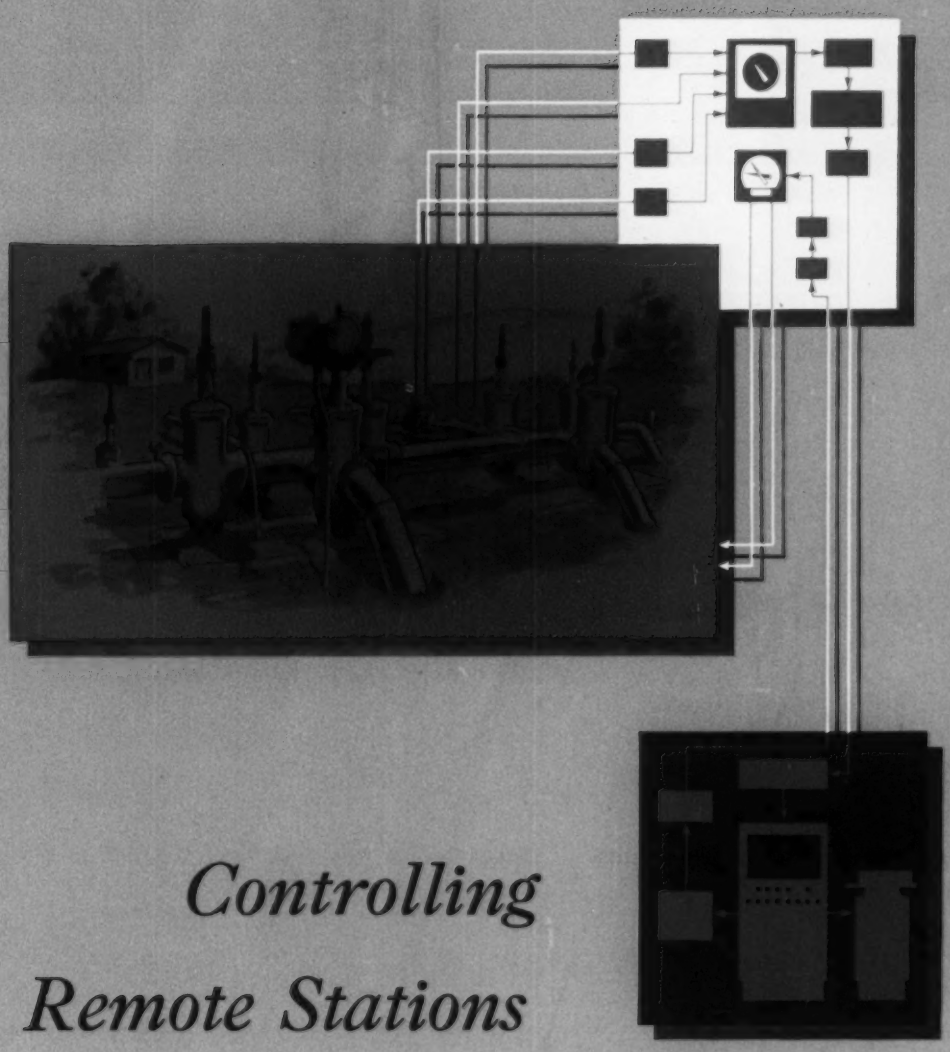
AUTOMATION

OCTOBER 1961



Controlling Remote Stations

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- A Look at Investment and Payback
- Handling Large Molds
- Co-ordinating Drives in Multiple Motor Systems
- Testing and Sorting Resistor Blanks

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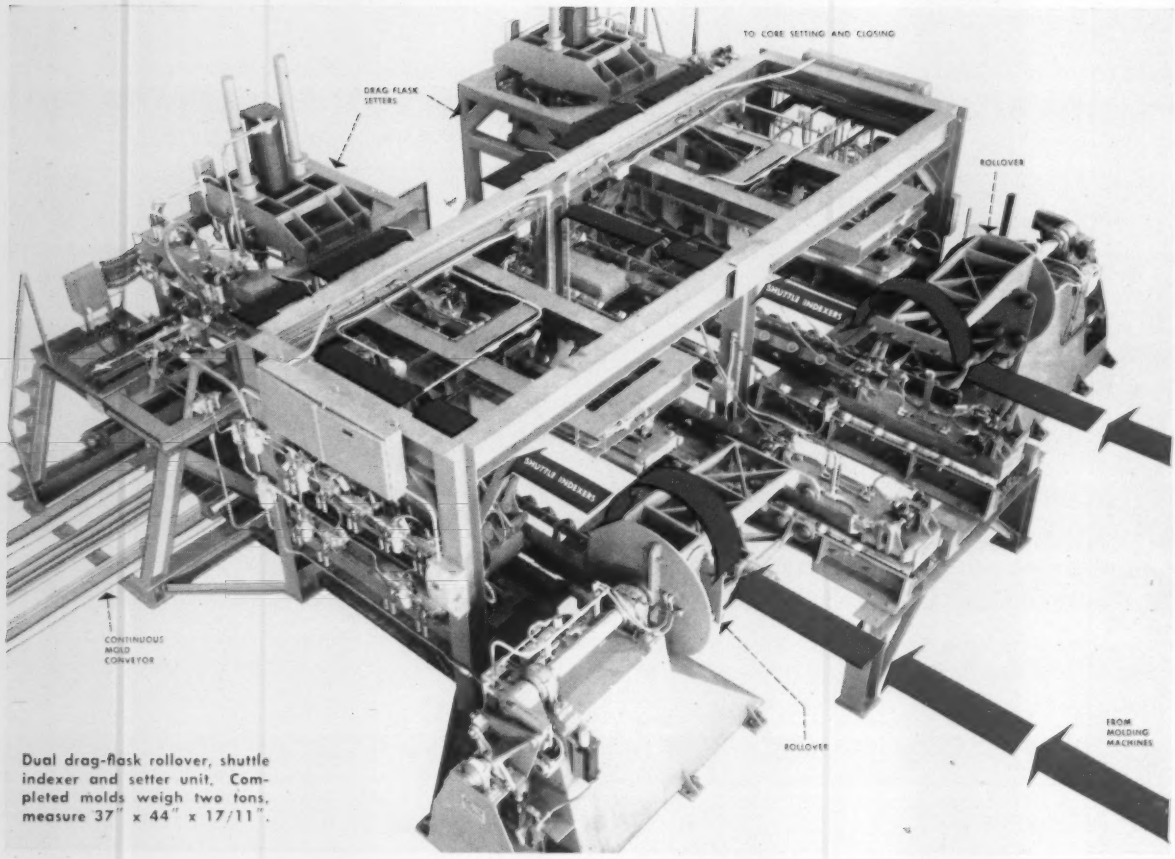
A PENTON PUBLICATION



Dual drag-flask rollover, shuttle indexer and setter unit. Completed molds weigh two tons, measure 37" x 44" x 17/11".

Planet system automatically removes and positions 250 one-ton flasks an hour on moving conveyor

To design a system that will strip and close flasks automatically on a continuously moving conveyor has always been a perplexing problem. But Planet Corporation solved this problem for one of the automotive industry's largest foundries . . . and at the same time provided the key to increase productivity approximately 400%. In addition, this unusual system provides maximum casting flexibility and operational reliability.

Flask Handling System Operation . . .

Following molding, the drag flasks are fed into the dual drag-flask rollover, shuttle indexer and setter unit (see diagram). The flasks are rolled over 180°, then indexed to the unique in-flight setters which accurately positions them on the continuously moving car-top mold conveyor. From this point, they are moved through core setting to the dual cope-flask-closing unit. The cope-flask subsystem, from molding to closing, is similar to the drag-flask unit except rollovers are not required.

After pouring and cooling, the cope-flask-stripper unit lifts the cope flask off the drag. The drag flask continues on the mold conveyor to the drag "pick-off", or lifting, device. On their removal from the conveyor, the flasks are recirculated through the system. Both removal operations are performed while the mold conveyor moves as a constant speed.

This integrated materials handling system *increased productivity approximately 400% and resulted in substantial cost savings.*

Production Flexibility . . .

With this flask handling system, it is possible to produce either six-or four-cylinder blocks or both simultaneously. This feature provides this large automotive foundry with maximum casting flexibility . . . a maximum capacity of 500 blocks an hour.

Built-in Reliability . . .

Flasks handled by this system are controlled electrically and are locked at each position. They are parted or joined by lifting or lowering movements to eliminate damage to parting surfaces. The control system, which required more than 10 miles of wire and 600 relays, includes a feedback feature which allows pinpoint maintenance.

For additional operational reliability, this system was shop wired and piped, and shop tested.

An Example of Planet Versatility . . .

This is one example of Planet Versatility . . . Planet Corporation's ability to engineer, fabricate and install custom equipment that solve materials handling problems. Planet Versatility means you'll benefit from our diversified experience gained through service to leading corporations. It has paid them to plan with Planet . . . it will pay you, too! Write or call for complete information.

Sales Offices in Principal Cities in the United States and Mexico

PLANET CORPORATION
1810 SUNSET AVENUE
LANSING, MICHIGAN

- Engineered Handling Equipment
- Automation Equipment
- Mill & Foundry Equipment

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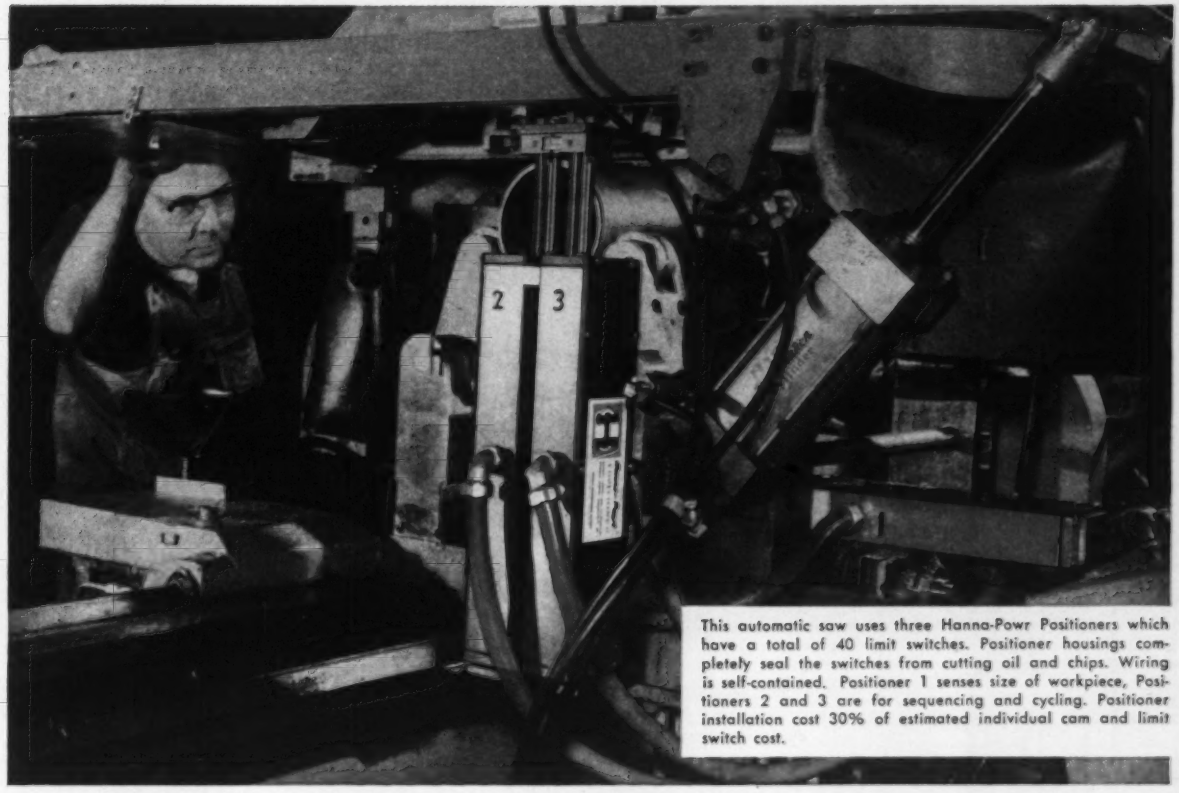


This automatic saw uses three Hanna-Powr Positioners which have a total of 40 limit switches. Positioner housings completely seal the switches from cutting oil and chips. Wiring is self-contained. Positioner 1 senses size of workpiece, Positioners 2 and 3 are for sequencing and cycling. Positioner installation cost 30% of estimated individual cam and limit switch cost.

Start a cam and limit switch COST REDUCTION PROGRAM!

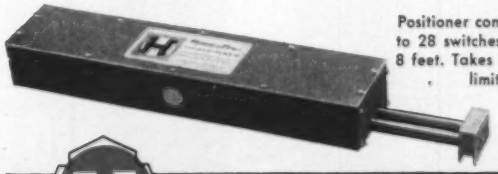
You can cut cam and limit switch costs up to 70% by using the Hanna-Powr Positioner — a compact, dust and water-tight housing containing cam rods and limit switches.

Because the Positioner is a pre-engineered assembly, it saves time used in designing special cams and mountings. Installation costs are cut, too, because it is only necessary to mount one box (4 screws) rather than individual switches and cams. Wiring is greatly simplified. The Positioner housing serves as a junction box—one conduit connection does it.

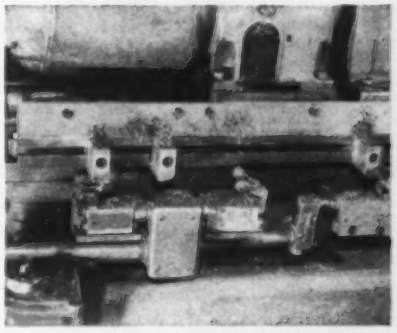
The switches can be moved easily and locked quickly in place after installation. This speeds set-up time for new jobs and makes pre-calculation of stops unnecessary. Safety is another big advantage—the switches cannot be tripped accidentally.

In addition to lower initial costs —maintenance, replacement, and down-time costs are cut. Switches last longer due to the protection (from dirt, chips, fluids and damage) afforded by the sturdy, extruded aluminum housing.

Use Hanna-Powr Positioners for cycling, sequencing, positioning, sensing and indicating. Many are in use and have been thoroughly tested in a variety of applications. It's a practical approach to automation.



Positioner containing switches and cam rods. Up to 28 switches per foot of travel. Any travel to 8 feet. Takes standard miniature or heavy duty limit switches, single or double throw.

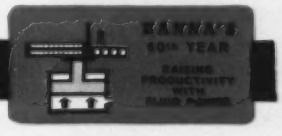


Examine your cam and limit switch costs. $35 to $75 per switch is the cost companies have fixed for designing, machining, installing, wiring, and adjusting limit switches and cams. This photo shows a typical high cost installation where oil, chips and accidental damage cause high failure rates and increased maintenance costs.

Write for complete catalog or consult Sweets' Product Design File section 9A/HA. Your Hanna Representative will also give you complete information—see the yellow pages under cylinders.

Hanna Engineering Works

1753 Elston Ave., Chicago 22, Illinois
AIR AND HYDRAULIC CYLINDERS, VALVES, POSITIONERS



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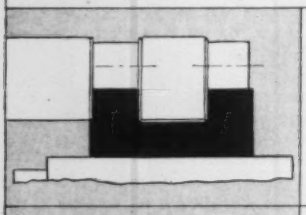
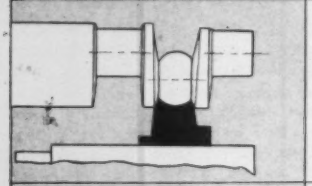
Eccentric Forming on Greenlee Automatic Bar Machines

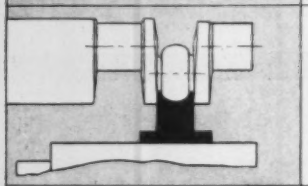
MACHINE . . . 1-5/8" — 6 Automatic Bar Machine
TOOLING . . . High Speed Steel
MATERIAL . . . B1112
STOCK SIZE . . . 1" round
TOOL SLIDE STROKE . . . 1-3/16" at .0042" feed
SPINDLE SPEED . . . 420 rpm 110 sfm
MACHINE TIME . . . 43 seconds
ESTIMATED GROSS PRODUCTION . . . 83 per hour



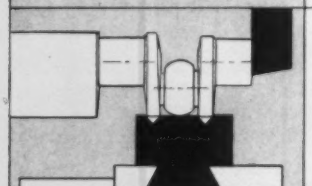
1. Rough eccentric form .550" diameter and 1/32" radius.



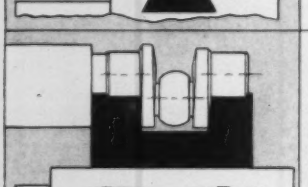
2. Rough eccentric form .643" spherical diameter, finish form inside tapered sides, and 1/32" radius.



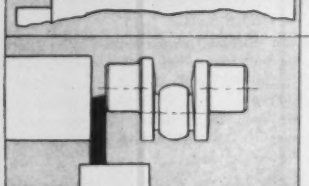
3. Finish eccentric form .643" spherical diameter and .023" radii.



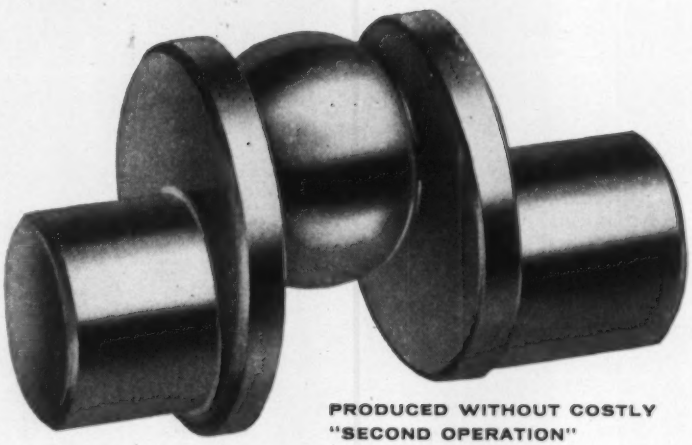
4. Face end. Break corners on 1" diameters.



5. Finish eccentric form .550" diameter, outside tapered sides, 1/64" radii, chamfer 45° on ends, and break-down for cutoff.



6. Cut off.

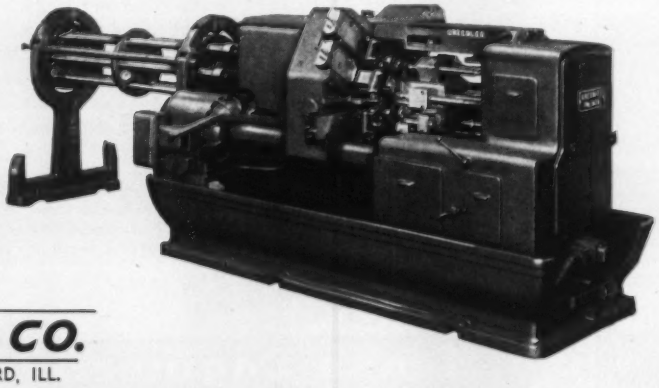


PRODUCED WITHOUT COSTLY "SECOND OPERATION"

"Union Special" relies on GREENLEE versatility to cut production costs of multiple eccentric crankshaft

Standard Greenlee Automatic Bar Machines are extremely versatile. Union Special Machine Company, manufacturers of industrial sewing machines, utilizes this production versatility to machine the multiple eccentric crankshaft illustrated. The part is machined from 1" round B1112 stock and is held in standard concentric collets. Part is machined in 43 seconds giving a gross production output of 83 pieces an hour. Sequence of operations is shown at left.

Special eccentric forming attachments mounted in the first, second, third, and fifth forming slide positions, rough and finish form the two eccentric diameters. Greenlee Bar Automatics permit greater job versatility and assure added profits. See your Greenlee representative or send us a print of your problem-part.



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OCTOBER 1961
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AUTOMATION

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Penton Building, Cleveland 13, Ohio

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around the triangle

CONTINUOUS LAUNDERING SYSTEM INTRODUCED

Commercial laundering machine handles flat-work pieces through the entire cycle of washing, rinsing, drying, and ironing, all in one continuous automatic operation. The soiled laundry is fed to the machine by a conveyor belt and the work emerges completely laundered at a speed between 100 and 150 fpm. The equipment is being marketed by Jet Stream Products Inc., a new corporation owned jointly by Chance Vought Corp. and International Textile Maintenance Equipment Corp.

POROUS PANELS SOLVE BIN PROBLEM

Porous stainless steel panels used to line automatic feed equipment have helped reduce the problem of poor bin discharge of powdered or fine materials. Inert gas or compressed air is blown through the porous panels lining the bin. Additional gas is blown into the packed powder by means of perforated probes. Four panels used in the throat of each bin are hung on the existing walls of the bin. The porous probes are placed farther up the bin wall and along the valley angles to prevent possible localized bridging. Pall Corp. supplied the porous liners and probes.

MASS SPECTROMETRY IN THE FIELD

Lightweight instrument, to identify constituents of gas mixtures in vacuum systems and indicate their relative content, is suitable for use on production lines. The magnetic-deflection type mass spectrometer weighs less than 40 lb and is able to differentiate individual mass peaks up to mass 150. The spectrometer tube is small enough to be placed on a standard vacuum system and baked out. The mass spectrometer and magnet, assembled into an integral unit, can be baked at 450 C. Individual mass readings from the partial pressure analyzer can be automatically displayed on x-y recorders or on a strip chart recorder. General Electric Co. developed the instrument.

MECHANICAL PAINTER FOR SHIPS AND STORAGE TANKS

A device, resembling a small army tank, has been designed to prepare and paint large areas of relatively smooth metal surfaces at a speed of approximately one-half a foot a second. In one continuous operation a mechanical chipping tool prepares the surface and a pressurized roller applies the paint which is fed through a hose. Magnets set into rubber treads, similar to those on tanks, keep the painting unit stuck to surfaces. An air-operated turbine connected to the treads drives the device. Direction can be either horizontal or vertical and is decided on by an operator using pneumatic controls. Device was designed by Esso Research and Engineering Co.

TAPE CONTROL AND COMPUTER SPEED CRYSTALLOGRAPHY

Automatic technique of studying crystals by x-ray diffraction has been developed by Bell Telephone Laboratories. The technique involves the use of a high-speed, general purpose, digital computer to generate a control tape which automatically operates a special x-ray diffractometer. Data readings from the crystallographic experiment are automatically recorded on another punched tape and the data is then fed back into the computer. The computer correlates the information, corrects for experimental factors, and prints out crystallographic data in a form convenient for analysis by a crystallographer. With equipment which is being built it is expected that more than 17,000 readings a day can be taken using this technique.

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BPA NBP

...Fluid Power news

OILGEAR 1921 1961 40 Years of Fluid Power

Report No. 11,807 From Oilgear *Application-Engineering* Files

How OILGEAR *Any-Speed* Drive Systems on revolutionary, new, continuous pipe mill provide up to 30% over and under base lineshaft speed for each stand—controlled to ±0.1% accuracy . . . maintain constant interstand speed ratios.

USER: *Lorain (Ohio) Works, National Tube Division, United States Steel Corp.*
Machine Builder — Aetna Standard Division, Blaw-Knox Co., Pittsburgh, Pa.
Differential Drive Manufacturer — Beloit Iron Works, Beloit, Wis.

PROBLEM: To provide accurate, efficient, independent, variable speed drive and control systems between a 1000hp lineshaft drive and 14 form-weld, stretch-reduce stands, and rotary flying hot saw of a new, continuous, buttweld pipe mill designed to produce approx. 237,000 tons of 1¼" to 4" buttweld pipe annually from flash-welded, endless webs of skelp. Delivery speeds range from 700 ft/min. of 1¼" pipe to 150 ft/min. of 4" pipe.

DRIVE REQUIREMENTS: 1. "Hard", non-resilient characteristics of direct gearing — with provision for infinite, variable speed control of any or all stands from 30% under to 30% over predetermined base lineshaft speed. 2. Accurate, preset, speed ratios between stands, capable of precisely maintaining transmitted differential loads to 150 hp — without drift — regardless of load change or lineshaft speed variation. 3. Optional, remote, automatic, "preset", and remote manual control. 4. Direct-reading, constant, visual indication of torque being pulled at each stand, and speed ratios between all adjacent stands. 6. Drive a rotary, flying cut-off saw at maximum mill delivery speeds — synchronized with speed of last active mill stand. 7. Must be compact, with trouble-free dependability for continuous, heavy-duty drive service. 8. One reputable source and responsibility preferred.

OILGEAR *Application-Engineered* HYTAC* Drive System For Continuous, Buttweld Pipe Mill

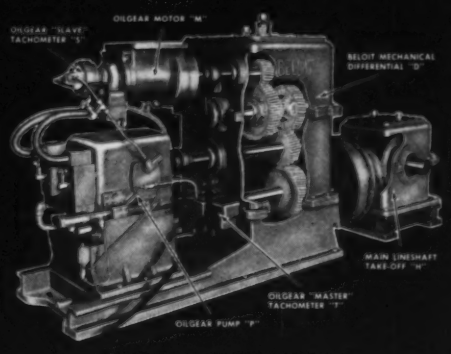
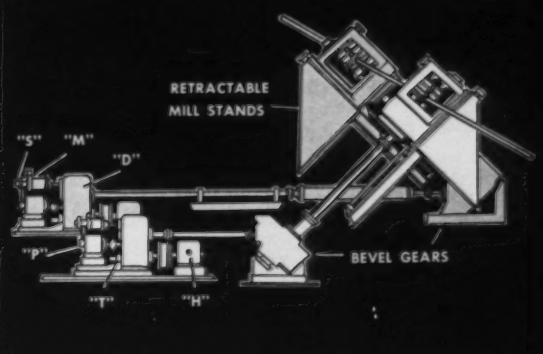


Photo Courtesy of Beloit Iron Works

LEFT: Fluid from Master Tach (T) gives stand drive speed command to control on Pump (P). Slave Tach (S) — direct-connected to Drive Motor (M)—feeds back a flow signal proportional to actual drive speed. Through remote, pushbutton control stations connected to electric pilot motor on Master Tach (T), operator can vary speed of each, or all stands infinitely up to 30% over or under base line-shaft speed . . . with accuracy to ±0.1%. **RIGHT:** Two typical stands of seven stand stretch-reduce mill. Each stand is mounted on a steel sled—45° to horizontal—90° in relation to each other. Sled stands are movable by a hydraulic cylinder. A hydraulic clamping mechanism holds sleds in selected positions. Six pipe sizes can be rolled without changing rolls.



SOLUTION: Oilgear *Application-Engineered HYTAC** — Beloit Mechanical Differential Drives provide precise speed and ratio control for 7 form-weld stands, 7 stretch-reduce stands, and a rotary, flying cut-off saw. Overall mechanical efficiency has been determined as well above 90% at full load . . . with remotely controlled speed variable up to 30% over and under base lineshaft speed for any one or all stands — with accuracy maintained within ± 0.1%. Production speeds required for a given pipe size can be preset within a small fraction of 1% — and duplicated at any later date. In this precisely controlled process — a National Tube innovation — the buttwelded pipe is both elongated and reduced in diameter . . . *with wall thickness and pipe diameter held to extremely close tolerances by the accuracy of interstand speed ratios.* An Oilgear "Any-Speed" Drive and Control System automatically synchronizes the rotary, flying cut-off saw with maximum delivery speed of the last active stretch-reduce stand — to cut the continuous pipe in accurate, predetermined lengths.

BIBLIOGRAPHY: *Steel Magazine, Dec. 12, 1960, Page 86; Automation Magazine, May, 1961, Page 68; Steel Magazine, Jan. 30, 1961, Page 114; A paper — "Variable Speed Hydro-Mechanical Drive", by Charles W. Modersohn, Staff Engineer, Beloit Iron Works, presented at N.C.I.H., Oct. 21, 1960.* ⓘ *See Oilgear Fluid Power NEWS 8, 11, 15, 16 — available on request.*

*HYTAC is an Oilgear Company registered trademark.

Installation of Oilgear-Beloit Variable Speed Hydro-Mechanical Drive and Control Systems — successfully pioneered on paper machine drives ⓘ — have exceeded originally specified requirements — without "start-up" problems . . . indicating the value of Oilgear's *Application-Engineering* teamwork throughout all stages of design, building, installation, and testing.

For accurate synchronization of multiple, tandem operations; for combining separate operations to handle webs, tows, or sheets — soft and fragile at one point, strong at another; for continuous operations where tension affects quality — or determines dimensional tolerances . . . all need MORE than conventional drives and controls — they need the precision of Oilgear "*Any-Speed*" Drives and Controls. User's state — "*For the lowest cost per year — with the most advanced, precision controls known to industry . . . it's Oilgear — the pace-setting pioneer!*"

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . . . .

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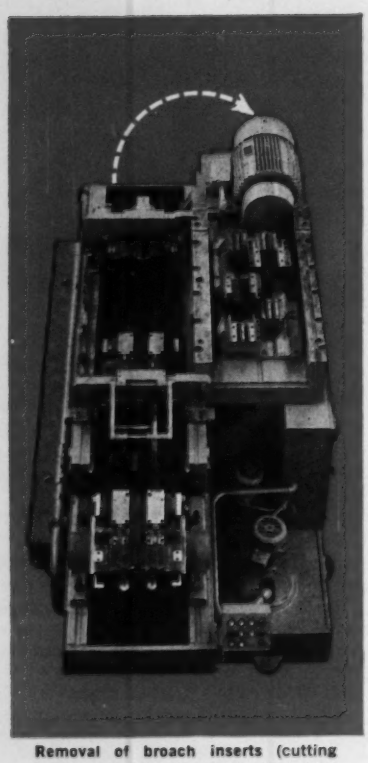
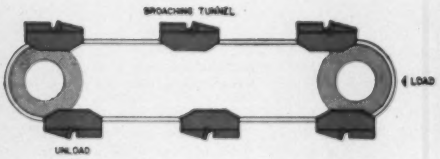
New CINCINNATI *Chain Broach*

IS ADAPTABLE TO CHANGE



Removal of broach inserts (cutting tools) for re-grinding is facilitated by merely opening the hinged top, as illustrated here.



Chain broach principle: a closed loop continuous production cycle. Fixtures indicated in red can be replaced or more added.

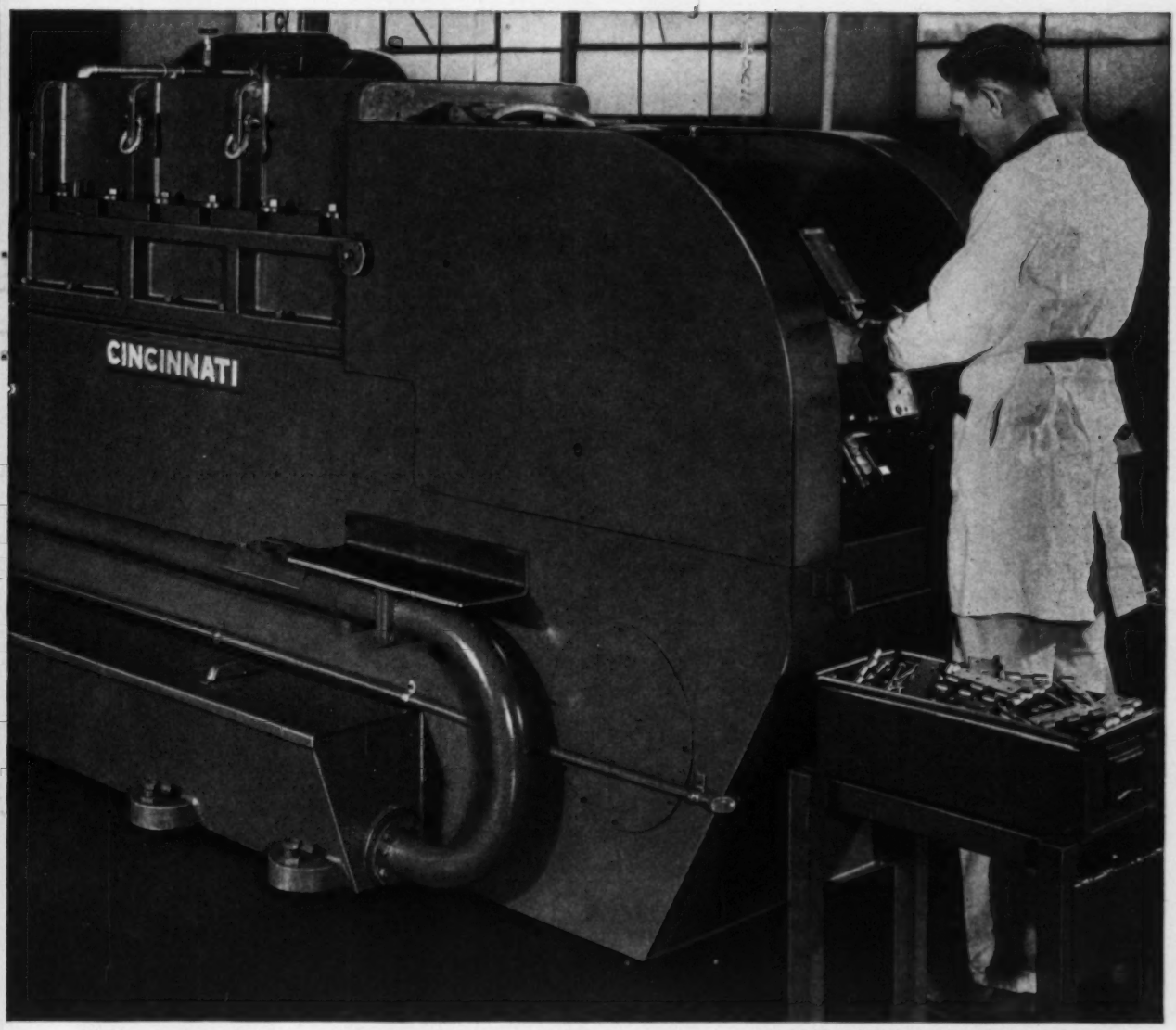
CHAIN BROACHING implies very high production. But very high production equipment sometimes limits design changes in the part. New CINCINNATI Chain Broach Machines retain the high production characteristics of closed loop cycles while adding a new advantage . . . they're adaptable to change. A unique method of attaching the work-holding fixture to the chains permits a welcome freedom of replacing or adding fixtures.

Straight-line traverse of fixtures through the broaching "tunnel" is assured by extra rugged guide bars. A pressurized coolant system and an endless conveyor automatically remove chips. To facilitate maintenance and adjustment of broach inserts (cutters), the top of the broaching tunnel is hinged and can be readily opened.

The CINCINNATI Chain Broach illustrated above is tooled up to

DESIGNERS AND BUILDERS OF SPECIAL MACHINES • HORIZONTAL BROACHING MACHINES •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

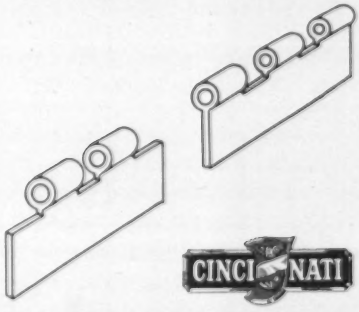


Photograph courtesy of Lawrence Brothers, Inc., Sterling, Illinois

New CINCINNATI Chain Broach Machine. Can be built in various sizes and tooled up for many types of high production jobs, such as machining the door hinge leaves shown below. Automatic chip disposal system is seen at front of machine.

broach door hinges for a prominent Illinois manufacturer of builders' hardware. Interchangeable fixture elements accommodate several sizes. With the exception of manual loading, the complete cycle is automatic and continuous, resulting in a production rate of 924 hinge leaves per hour.

The new Chain Broach Machine is a typical example of advanced thinking and modern approach to low-cost production which Cincinnati imparts to broaching and other metalworking machines and production lines. Many specialists in Cincinnati's Special Machine Division are available to study your machining problems and recommend equipment to reduce costs and improve quality. May we give you more information?



COMPLETELY AUTOMATED PRODUCTION LINES

CINCINNATI®
SPECIAL MACHINE DIVISION

Circle 656 on Page 119

COMPLETE, COMPACT "PACKAGE" DRIVE SYSTEMS ON DEMAND

ACF ADJUSTABLE SPEED CONTROLS require no warm-up time—respond instantly to remote or local control signals or load changes. Low-voltage-drop Silicon Controlled Rectifiers and patented ACF Magnetic Triggering "nerve center" eliminate need for tubes or MG set—insure silent operation and longer life. ACF drive systems, easier to install and maintain, are superior in any application requiring adjustable speed at constant torque.

ACF STEPLESS MOTOR CONTROLS, operating from an AC source, are smaller, lighter, more economical than competing systems—give smooth, precise regulation over a wide range of speeds regardless of load variations. ACF drive systems, for both fractional and integral HP operation, are available as off-the-shelf items. For full information, write or call Paramus Plant. 11 Park Place, Paramus, N. J., telephone: COlfax 1-4100.

ACF ELECTRONICS
DIVISION

ACF INDUSTRIES

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automation outlook

By **ROGER W. BOLZ,** Publisher and Editorial Director

VOLUMES OF DISCUSSION in and out of government circles in recent months have dwelt on automation, unemployment, and jobs. Jobs are discussed as a thing everyone is entitled to have as a right, *not* something to be earned and held by effort and enterprise.

Some have even stated that industry's responsibility is to provide jobs.

Few investigations to date have bothered to deal with the stark realism of industrial enterprise and evolutionary change. Industry was created and has developed to serve the material needs of the population, not merely to provide jobs. The entrepreneur makes a job for himself and others by developing a service or product that attracts customers. American freedom and free enterprise created the conditions under which all are free to take advantage of unfettered opportunity to make themselves or the product of their skills and thinking valuable to others, even indispensable.

A hundred years ago the same dire predictions were being made about machines that today are being attributed to automation. Yet in the process of time under the relentless force of economics and demand, technological change has continued with better and better results. Nevertheless, all through these hundred years there have been ups and downs, upheavals, and difficulties. Why?

Certainly the history of industrial growth has not been one of machines creating problems. Consumer demand and outlook has in large part been the troublemaker. Technological development is relatively slow and unsteady; by and large it results from stimulus of consumer demand. As the consumer's attitude, actions, and outlook swing in wide variations, industrial effort to serve follows suit with tremendous backwash effect on the fortunes of all workmen involved throughout a great interwoven maze of connected services. The consumer and jobholder for the most part is the victim of his own choices and whims.

Significant need for today and tomorrow is for the development of business conditions that stimulate new enterprise. Depressive taxes must be reasonably reduced. No real solution can be expected with laws that in the end militate against employment (no matter how socially desirable) or that create unnecessary barriers to expansion, research and productivity advance. Oversimplified and politically potent temporary remedies must be carefully evaluated so that in helping alleviate unnecessary hardship no irreparable long-range problem is created as has been the case with farming.

Traditional American freedom and free enterprise can be expected to solve our employment problems most effectively but more effort must be made to insure full and detailed understanding of the interworkings of our complex economic system. It is imperative that every person that

aspires to a high living standard be stimulated to develop and grow, to set aside a reasonable effort toward self improvement, to recognize his responsibility and contribution to American enterprise, and to expect that rewards will be commensurate with interest, quality and effort expended.

Automation and technological change will always have their profound effects on the industrial scene but only through an honest attack at the roots of the problem can we expect a smoother transition with time. The public itself holds the main answer and it always spells effort, interest, study and understanding. The American way, with freedom of choice, includes as a fundamental part the freedom to choose how hard one cares to work for a return. There can be no compromise with the Biblical lesson of the talents. It is still true today.

IN ITS FOURTH YEAR of activity, the Foundation for Instrumentation Education and Research can look back on some impressive achievements. Graduate work in instrumentation has risen over 30 per cent, Ph.D. degrees 150 per cent, total FIER projects, grants, fellowships, etc., have multiplied over five times. Industrial support for this important work is growing but much more interest in this kind of activity should be forthcoming.

FASTEST DIGITAL COMPUTER ever built is now in operation at MIT's Lincoln Laboratory. "FX-1" is ten times faster than any computers in general use today. Its significance lies in its unusually high speed using for the first time thin magnetic films in the main memory. Read-write cycle time is 0.3 microsecond. Today processing speed no longer poses any problem for business or industrial applications. Systems applications engineers indicate that the real effort now must be directed toward compatible and accurate input programs and well organized output reports.

A RECENT SEC-COMMERCE survey of business plans indicates an upward turn in the third quarter. We foresee a strong upward trend by the fourth quarter and a significant increase for the year over our January forecast of $6.8 billion in capital expenditures for automated equipment and controls.

HOW NEW PROCESSES CREATE DEMAND for higher level control systems is well illustrated by DuPont's basic material for synthetic fibers, acrylonitrile. A time-varying, nonlinear reaction, the process does not produce the same output each time with a given input of energy and material. To prevent formation of unwanted products, new computer techniques of control are being researched jointly with IBM. DuPont's Charles B. McCoy emphasizes that labor cost reduction is not the purpose behind introduction of automated control, "In this work we are looking toward the blending of modern chemistry, mathematics, and machine computation to enable us to do things we cannot do in any other way."

CHROMALOX ELECTRIC HEATERS

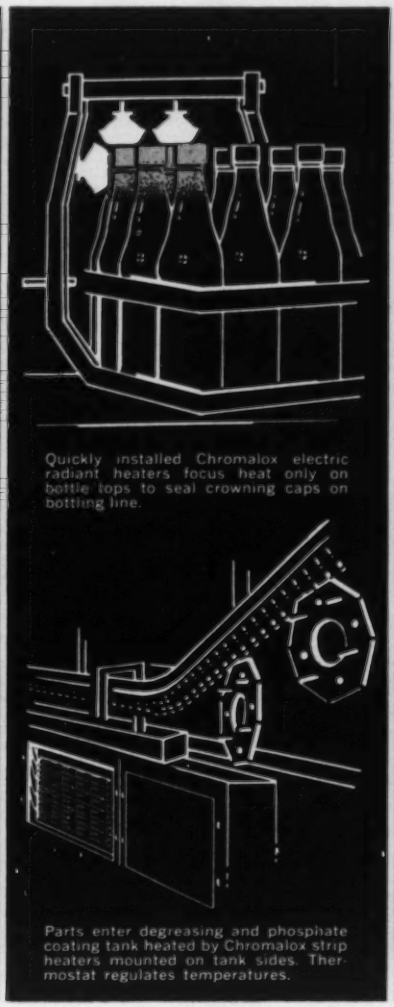
provide precise, uniform heat centers on automated operations, regardless of product size or shape

Precise control, from 4 to 100% of output, can be made an integral part of a Chromalox far-infrared heating installation. Temperatures are "dialed."

Compact far-infrared units interlock into self-forming ovens. Single or double heat sources in lengths from 24" to 185", many wattages.

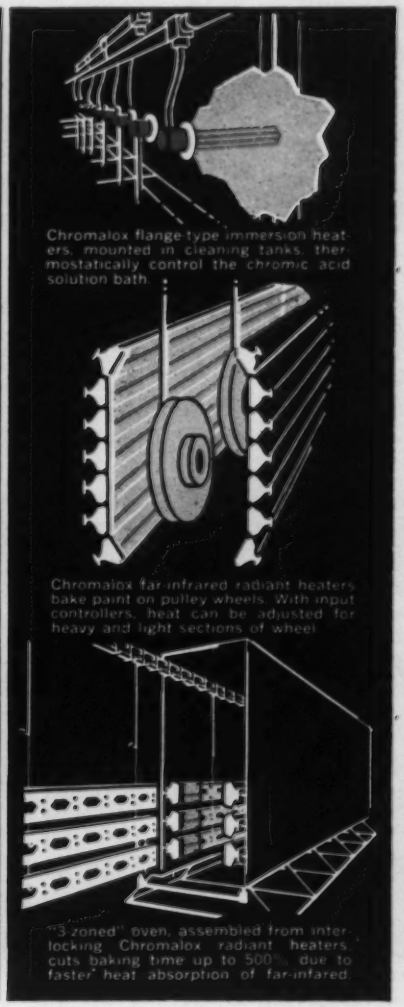
Straight lengths, formed or "finned" Chromalox strip heaters in 50 to 6,000 W; ¾", 1", 1½" widths; 5" to 96" lengths.

Chromalox immersion heaters — for heating water, oil and other liquids. 3" to 14" pipe flanges— with or without built-in thermostats.



Quickly installed Chromalox electric radiant heaters focus heat only on bottle tops to seal crowning caps on bottling line.

Parts enter degreasing and phosphate coating tank heated by Chromalox strip heaters mounted on tank sides. Thermostat regulates temperatures.



Chromalox flange-type immersion heaters, mounted in cleaning tanks, thermostatically control the chromic acid solution bath.

Chromalox far-infrared radiant heaters bake paint on pulley wheels. With input controllers, heat can be adjusted for heavy and light sections of wheel.

"3-zoned" oven, assembled from interlocking Chromalox radiant heaters, cuts baking time up to 500% due to faster heat absorption of far-infared.

Chromalox electric heating equipment can help you automate your production lines to cut costs, improve production and/or reduce rejects . . . as well as solve many of the critical heating problems encountered in line production. They are frequently used to boost existing heat-source temperatures. Among the Chromalox advantages are easy, low cost installation; dependable and economical operation; minimum attention and maintenance. Whatever your need for heat—whether for production-line or other processing applications—Chromalox electric heaters can provide exactly the heat source you require. Engineering assistance is available without obligation. Write, wire or phone.

FOR YOUR INFORMATION

Write for Catalog 60. It details uses for electric heat and describes thousands of types, sizes and ratings of Chromalox units.

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FIRST NAME IN ELECTRIC HEAT

CHROMALOX ELECTRIC HEAT

PROCESS | COMFORT

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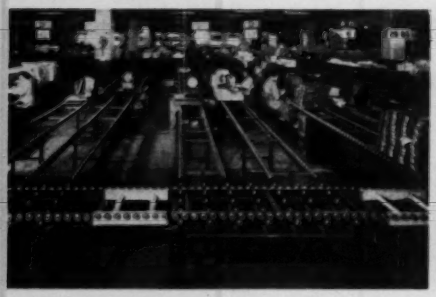
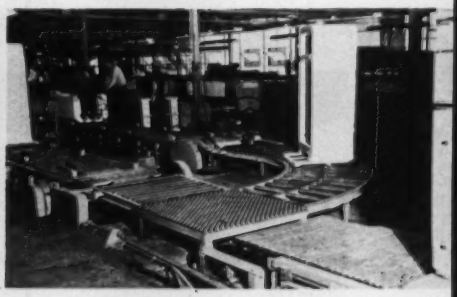
CUT YOUR HANDLING COSTS



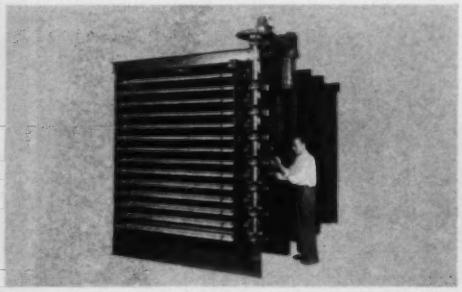
Single-row wheel conveyors as used in department store marking rooms

Powered belt conveyor. Horizontal and inclined with rubber, canvas or wire mesh belts

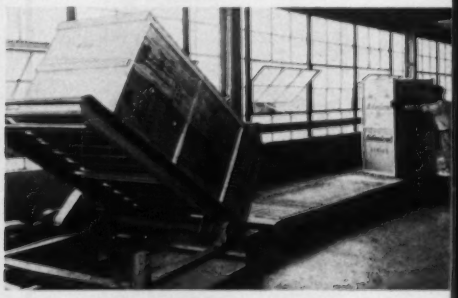


Apron conveyor assembly lines, ball-transfer switching station, in major appliance plant

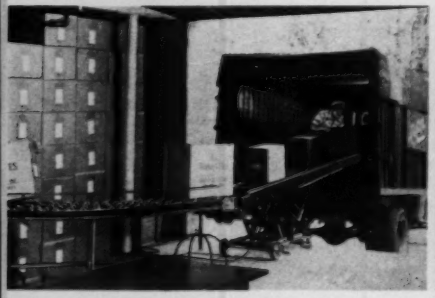
Overhead cable and roller conveyors, as used in wholesale drug warehouse for order picking



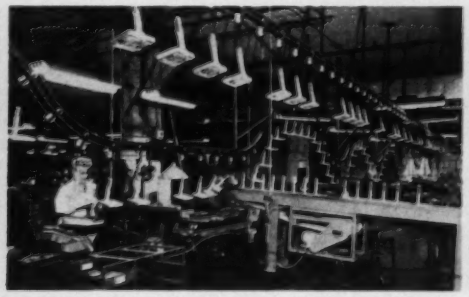
Automation. Special sheet feeder receives, stores and automatically loads and unloads curing press



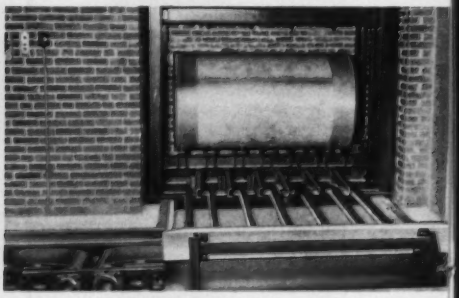
Up-enders, down-enders and special units are easily integrated into standardized conveyor systems



Portable wheel, belt conveyors: versatile in warehouses; shipping, receiving docks; stock rooms, etc.



Trolley carries light to medium weight loads, up, down, around all operations, at convenient heights



Automatic reciprocating hoist, belt conveyors handle paper rolls between floors in publishing plant

WITH BUSCHMAN CONVEYORS

ENGINEERED FOR ANY NEED IN ANY INDUSTRY

Buschman is your most logical source for a complete line of materials handling equipment, because they offer exceptional basic patent features and experience-engineering. From portable in-stock gravity conveyors to their famed Bush-Lock powered cable units, the Buschman line effects the greatest economy of space and handling costs in *any* situation. Here are a few typical applications that suggest how Buschman can serve *you*. The E. W. Buschman Company, 4551 Clifton Avenue, Cincinnati 32, Ohio.

Write for information on Buschman powered systems and in-stock gravity units for your use.

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Complete Conveyor Systems for all industries — Engineered, Manufactured, Installed.
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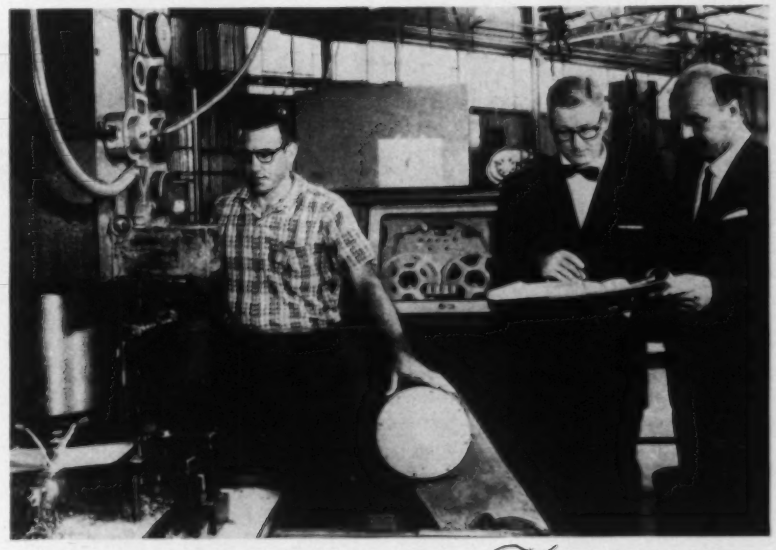
AUTOMATION news

Today's events and developments in the field of automation

NC Programming System Designed for Medium Computer

VERSATILE PROGRAMMING system has been developed to prepare instructions for different machine tool control systems by use of a single numerical control programming system with a medium-scale general purpose digital computer. The system, seen as especially useful to small and medium-size metalworking concerns, has been developed jointly by Remington Rand Univac and Rohr Aircraft Corp. for the Univac solid-state 80 and 90 computers. The programming system (known as a software package in computer groups) will handle automatic part programming for the following numerical control systems: Bendix, Cincinnati, ECS, Numericord, and Thompson Ramo Wooldridge. Programs will be available to all users of Univac solid-state computers. They will also be available on a job-lot basis to firms using facilities of a Univac service center to perform automatic part programming.

The program uses a part programmer manuscript which contains basic information relating to part geometry, feed rates, spindle speeds, and auxiliary instructions for the machine tool. This information is transferred to punched cards which are read by a high-speed reader and transmitted to a central processor where the data is interpreted and processed by the computer according to the internally stored program. Results are translated into numerical control codes and automatically punched into cards for use in control of the machine tools. The cards contain all the control data necessary to guide the tool through the complete manufacture of a part. For machines which cannot accommodate a card input, appropriate conversion is made to a control tape.



An engine mounting box beam is shown being milled from a steel forging by a Morey profiler under the guidance of instructions prepared by a new computer programming system. Checking the drawing from which these instructions were derived is Nils Olesten (center) general supervisor, Numerical Control Dept., Rohr Aircraft Co., and Dr. Gastone Chingari (right) director of numerical control applications for Remington Rand Univac.

Dispatch System Combines Power Control and Costing

COMPUTER-DIRECTED control system has been installed at the Philadelphia Electric Co. to automatically distribute system loads to generators for minimum power cost. The computer also makes cost determinations for inter-company billing purposes. By the end of this year, most of the company's 34 generating units at nine power stations will be under the automatic load control system. This includes 27 generators driven by steam turbines and seven driven by water power. The control system was developed jointly by Minneapolis-Honeywell Regulator Co. and Philadelphia Electric Co. All basic elements and nearly all components in the system were supplied by Minneapolis-Honeywell. The only moving elements in the solid state system are relays.

In making economic dispatch calculations, the computer uses information stored in its memory and the input readings for several variables. Stored information includes incremental production cost curves, fuel costs, performance characteristics of each controlled generating unit, and incremental transmission losses. Input variables cover total assigned steam generation, manually controlled steam units, hydro generation, power flow to and from interconnected utilities, and steam units available for allocation.

Hourly, the computer reads the amount of power being exchanged with the Pennsylvania-New Jersey-Maryland Interconnection and makes cost determinations for intercompany billing. These computations are punched on paper tape for further accounting use.

Block of NC Machine Tools Ordered

ORDERS for eleven numerically controlled machine tools costing over 3.3 million dollars were recently placed by Douglas Aircraft Co. The equipment is being funded from the Air Force Industrial Modernization Program for the purpose of updating Air Force owned industrial manufacturing capabilities. Included will be: Five 5-axis profilers, two 3-axis profilers, and two 4-axis vertical turret lathes to be built by Giddings & Lewis Machine Tool Co.; and four 4-axis milling machines to be built by Sundstrand Corp. Dynapath numerical contouring systems are to be supplied by Bendix Corp. to control the machines.

The machine tools will be installed in one of the Douglas plants on the West Coast. They will be joined by four additional numerically controlled machine tools which are to be purchased with Douglas funds.

ULTRASONIC ball point writing instrument suitable for industrial recorders has been developed by Ultrasonic Industries Inc. The device includes a small generator which develops high frequency oscillations that activate an ultrasonic transducer in a unit of size and shape comparable to a conventional pen or pencil. It does not require any writing fluids or marking compounds of any sort, and is capable of writing at a linear speed of 9000 fpm. The pen will write in extreme temperatures from zero to 500F, and is unaffected by dust or other airborne contaminants.

Packaging Show Coming Up

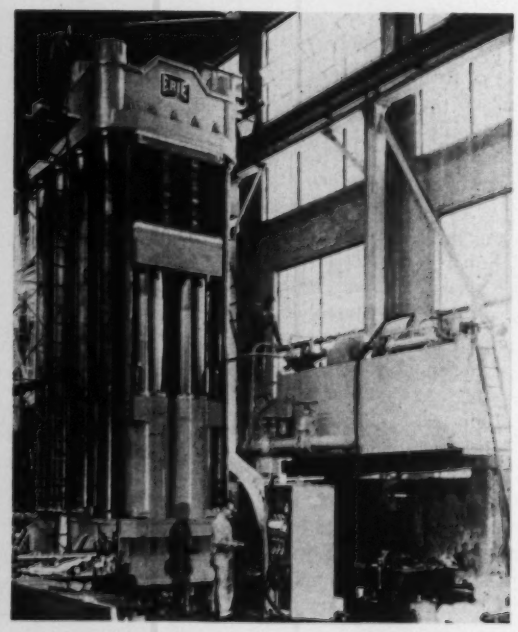
NOVEMBER 7-10 are the dates of the Packaging Machinery Manufacturers Institute Show which will be held in Cobo Hall, Detroit. Approximately 150 manufacturers of packaging machinery and related packaging materials will have displays.

Feature of the show will be a unique Conference-Workshop program to be held November 8 and 9. Theme of the Conference-Workshop will be "Planned Maintenance—The Profit Tool of Modern Management." Five conference presentations will be made November 8. In the workshop phase of the program on November 9, top authorities on preventive maintenance for packaging machinery will lead discussions. The audience will be divided into five groups with equal opportunities for discussion on the various topics. Roving discussion leaders will move from group to group, rather than having visitors move from room to room. This way visitors will have an opportunity to participate in all five discussion topics. Additional information is available from Hanson & Shea Inc., One Gateway Center, Pittsburgh 22, Pa.

Joint Effort Undertaken on Control Computer Systems

JOINT DEVELOPMENT of automatic control systems using electronic computers will be undertaken by Westinghouse Electric Corp. and Remington Rand Div., Sperry Rand Corp. The joint effort will be applied to automatic control of processes in industrial, marine, and other applications. Westinghouse will have system responsibility for supplying complete systems including installation and related services. Both firms will also continue their independent research and development. **A. C. Monteith**, Westinghouse vice-president and general manager, apparatus products, said, "This new joint development, bringing to bear on manufacturing process problems the combined experience and abilities of our two organizations, will result in an advanced line of the most modern and complete industrial control systems."

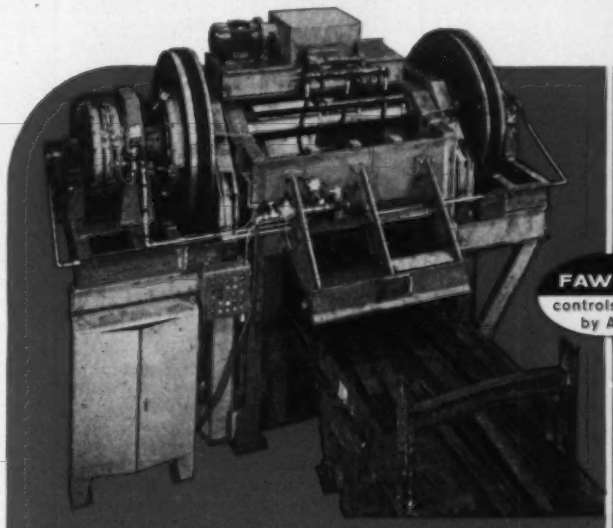
The respective programs will be headed up in the two companies by **Paul R. Sprowl**, manager of the industry systems department at Westinghouse, and **Dr. Valerius E. Herzfeld**, manager of industrial computers at Remington Rand. The combined efforts will result in the development of a new and advanced line of computers for the process control field. They will be capable of working with business data processing equipment.



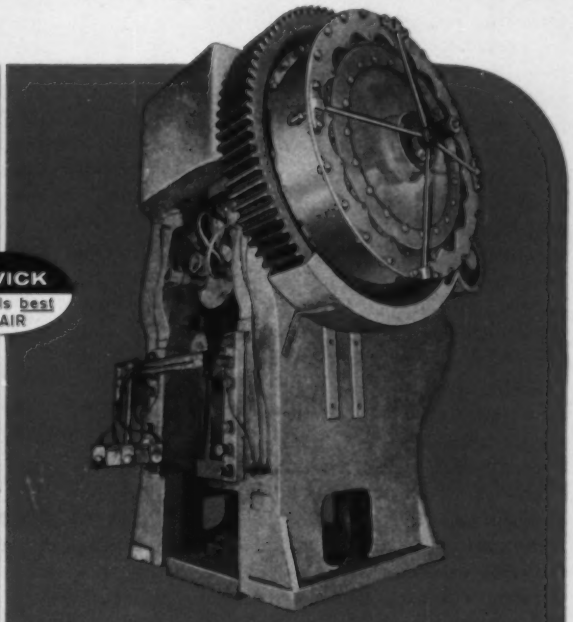
HYDRAULIC PRESS, built by Erie Foundry Co., is designed to produce decorative laminated boards for counter tops, panels, inlays, and other related applications at the Micarta Div., Westinghouse Electric Corp. It will automatically load, process, and unload 250 boards in an hour. The press stands 35 ft high, has 16 openings, and will take a board size of 70 inches by 154 inches. It has eight high-pressure hydraulic cylinders and eight heavy strain rods.

DESIGN or MODERNIZE HEAVY CYCLIC MACHINES

...with Fawick VC Ventorque Clutches



NEW rotary scrap shear incorporates advanced dual drive system using a Fawick VC Ventorque Clutch in each of two flywheels for synchronized power transmission. Clutches engage opposite ends of main drive shaft instantly, and simultaneously, to avoid shaft twist and provide even knife pressure during operation of the 585-ton-capacity machine. Automatic self-adjustment for wear assures equal torque transmission at opposite ends of shaft, cycle after cycle. Dual element VC Ventorque Brake at shaft end (left) provides braking torque. Shear was designed and built by The Hill Acme Company, Cleveland.



MODERNIZATION of this 600-ton press at major automotive plant has increased production and reduced maintenance downtime. Press Conversion Package includes crankshaft-mounted Ventorque Clutch and spring-applied CS Brake. Since installation three years ago, downtime due to replacement of clutch or brake parts has been completely eliminated.

. . . for *maximum production under severe conditions*

FAWICK VC Ventorque Clutches and Brakes provide the kind of rugged-duty power transmission that boosts production and precision on even the heaviest machines.

Machine operating speed or efficiency can be increased because Ventorque Clutches respond instantly and accurately. Drum-type air clutch design incorporates ventilated construction for continuous cooling. This keeps torque capacity high and clutch performance at its peak under the toughest operating conditions. Simplified design and cool operation insure long friction life and extremely low clutch maintenance costs.

Ventorques are available in 14 standard sizes with torque capacities from 27,000 to 1,800,000 in.-lbs. at 75 psi. Whether used as original equipment or for modernization, these units are easily installed on all types of heavy cyclic machines.

For complete engineering information and consultation on your application, contact your nearest FAWICK representative or the Home Office.

you can design or modernize these machines with VC Ventorque Clutches:

- power presses
- shears
- draw benches
- cut-off machines
- benders
- rolling mills
- upsetters
- seamers
- crankshaft lathes

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FAWICK AIRFLEX
INDUSTRIAL CLUTCHES AND BRAKES

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Magnetic Imprinting Used on Gas and Light Statements

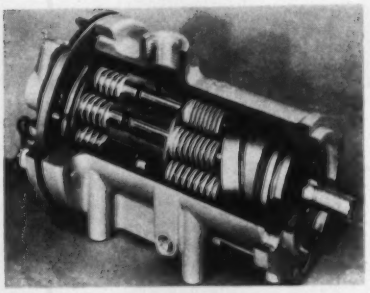
UTILITY company, Dayton Power and Light Co., has established an electronic data processing center and will use magnetic imprinting on customer bills. The system is built around two NCR 315 computers manufactured by National Cash Register Co. The use of magnetic imprinting will make possible the direct input of data into the computers. Monthly bills for gas and service will have a customer's account number preprinted in magnetic ink. Miscellaneous imprinting on new bills, final notices, and other forms will be accomplished by two NCR magnetic ink encoders.

When the bill stubs are returned for crediting of customers' payments, they are read by a sorter-reader which feeds up to 42,000 characters of information a minute directly into the computer. The computer posts the payments to customer accounts which are stored on magnetic card files. Over 15,000 payments can be electronically posted to customer accounts in 40 minutes. A card random access memory (called CRAM) contains replaceable cartridges with 256 magnetic cards and storage for over 8 million digits of information in each cartridge. The computer can select any card from a cartridge and read the information pertaining to a customer's account in one-sixth of a second.

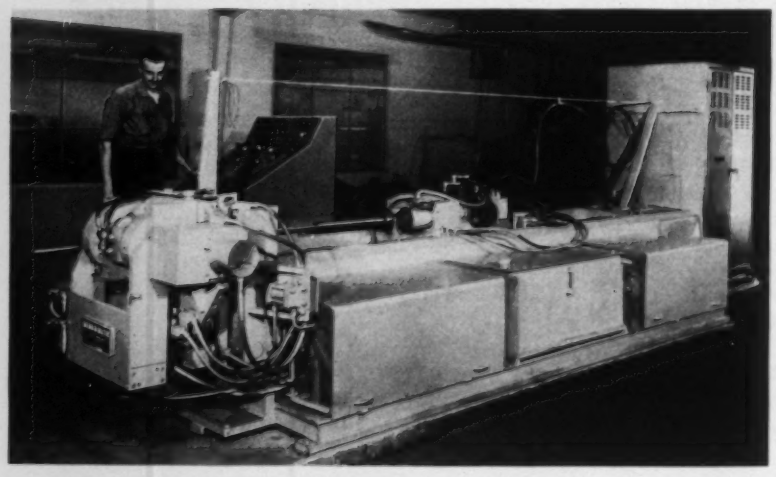
PNEUMATIC ANALOG computer has been developed for the process controls industry by AiResearch Mfg. Div., Garrett Corp. Using standard industry 3-15 psi pneumatic inputs, computer modules are available to add, subtract, multiply, and divide. They can also take ratios and square roots, as well as integrate, differentiate, serve as a function or test signal generator, and provide hold, or memory. By use of common components, which may be assembled in a variety of modules, this computer system offers great flexibility at low cost.

Army of Machines To Wire Panels

ORDER for 45 machines to automatically wire electronic panels, has been received by Gardner-Denver Co. for use by International Business Machines Corp. The machines will be used in their plants around the world. The units will be similar to others originally designed by Gardner-Denver for use by IBM in the building of solid-state computers. Under direction of punched cards, each machine is capable of attaching 750 spaghetti-thin wires to a 20 by 30 inch panel in two-and-a-half hours. Each insulated wire is cut from a spool, skinned, routed along a certain path, and wrapped connections made on two plated bronze pins within five seconds. In addition to wiring the panels, the machine also checks its own work. If a wire is not connected properly, the machine halts its operation until a technician corrects the mistake and starts up the machine.



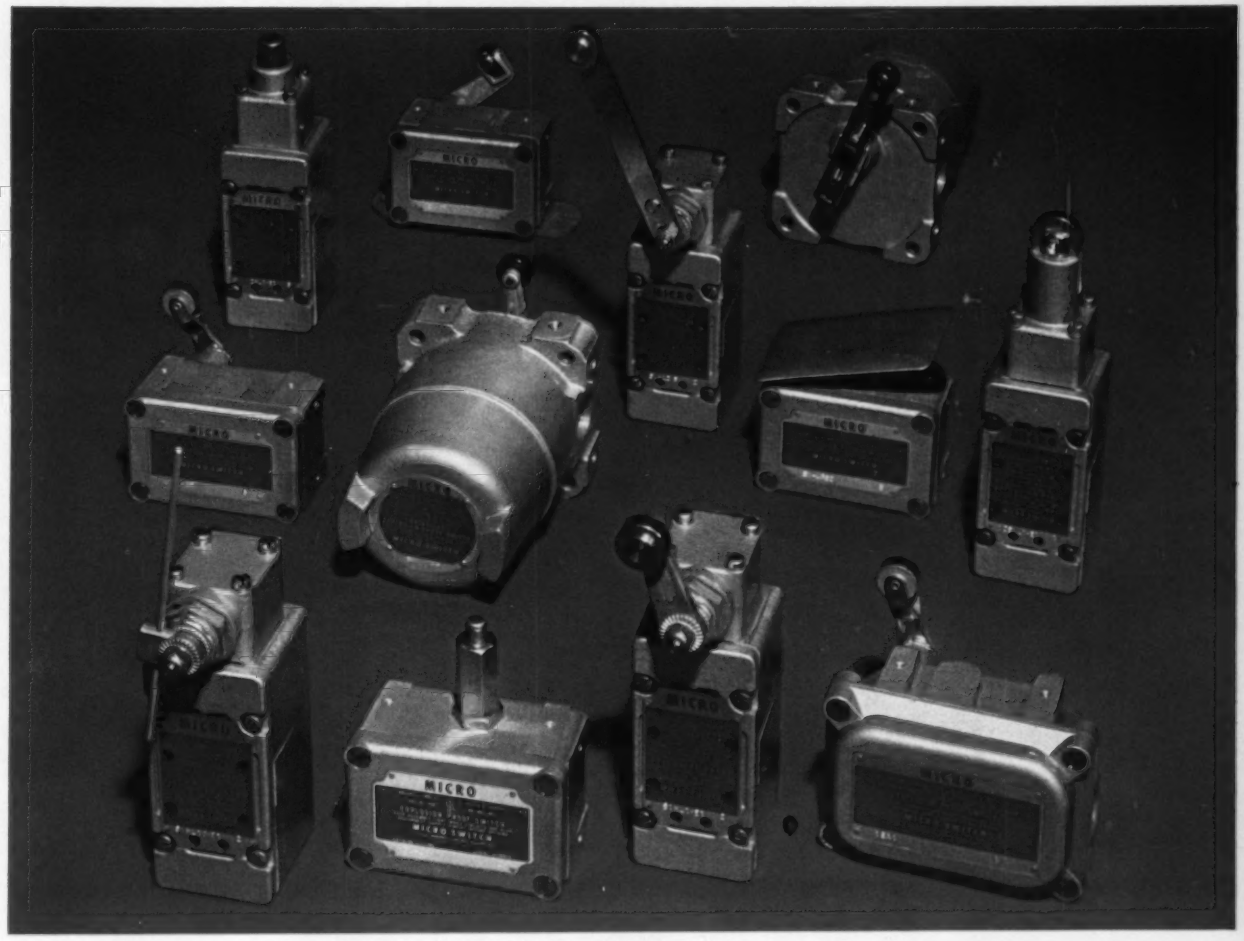
VARIABLE displacement hydraulic pump, illustrated by cutaway, has a non-rotating cylinder block with seven axial pumping pistons driven by fixed-angle rotating cam and non-rotating wobble-type reaction plate. The drive shaft and cam are the only two rotating components. Displacement is varied by shifting the cylinder block axially. Reaction pistons balance the hydraulic forces exerted on the cylinder block during pumping. With pumping forces virtually eliminated from the displacement changing mechanism versatile control options are available. They include: Internal pressure compensation; manual handwheel control with or without internal pressure compensator; manual lever control; servo control. Pump can operate continuously at no flow while maintaining full system pressure without additional power. Initial model in line is rated 9 gpm at 3600 rpm with pressures from 250 to 3000 psi. Unit was designed by Weatherhead Co.



TUBE BENDING machine, controlled by punched tape, has tape writer and tape reader equipment as an integral part of the control console. Tubes are loaded and unloaded by hand and the operator initially programs bends. The machine produces a punched tape with the first part, and subsequent parts are programmed by the tape. Three numerically-controlled motions are provided—tube advance, tube rotation, and tube bending. Nu-Era Corp. offers the machine for precision bending with tolerances of plus or minus three minutes on bend and twist angles and plus or minus 0.005 inch on length between bends. Built by Walter P. Hill Inc., the machine includes a bender unit to advance, turn, and bend the tube and a General Electric Mark III positioning system. It can handle tubing of any material up to 1¼-inch diameter and 8 feet long.

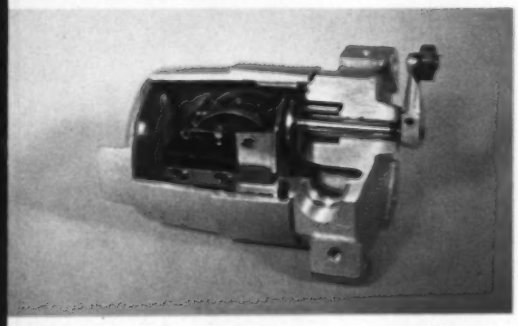
RIGID VINYL PIPE that withstands both boiling water and hot corrosive chemicals has been developed by B. F. Goodrich Industrial Products Co. The piping can withstand temperatures up to 200F and can take over functions in chemical and steel processing, paper manufacturing, and electroplating that were formerly handled exclusively by stainless steel or lined pipe. The new pipe weighs

Circle 661 on Page 119→



Added safety for switching in danger areas

EXPLOSION-PROOF Switches



"CX" series explosion-proof switches are rain and dust tight—valuable protection in hazardous outdoor locations. Note the two gasket seals and the accessibility for wiring to the two enclosed s.p.d.t. switching units.

MICRO SWITCH explosion-proof switches provide safe limit or interlock control functions in hazardous areas where there is danger of explosion of dust or volatile vapors. They are designed for heavy duty performance under the most severe operating conditions. The enclosed and well protected snap-action basic switching elements combine precision with long life.

All switches in this family are listed by Underwriters' Laboratories for use in hazardous atmospheres Class I, Groups C and D; Class II, Groups E, F and G. Some are also listed for Class I, Group B.

Available with a variety of actuators, circuit arrangements, electrical ratings, and operating characteristics.

See the Yellow Pages for the nearby MICRO SWITCH branch office or distributor, or write for Catalogs 83 and 84.

MICRO SWITCH . . . FREEPORT, ILLINOIS . . . A division of Honeywell

In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

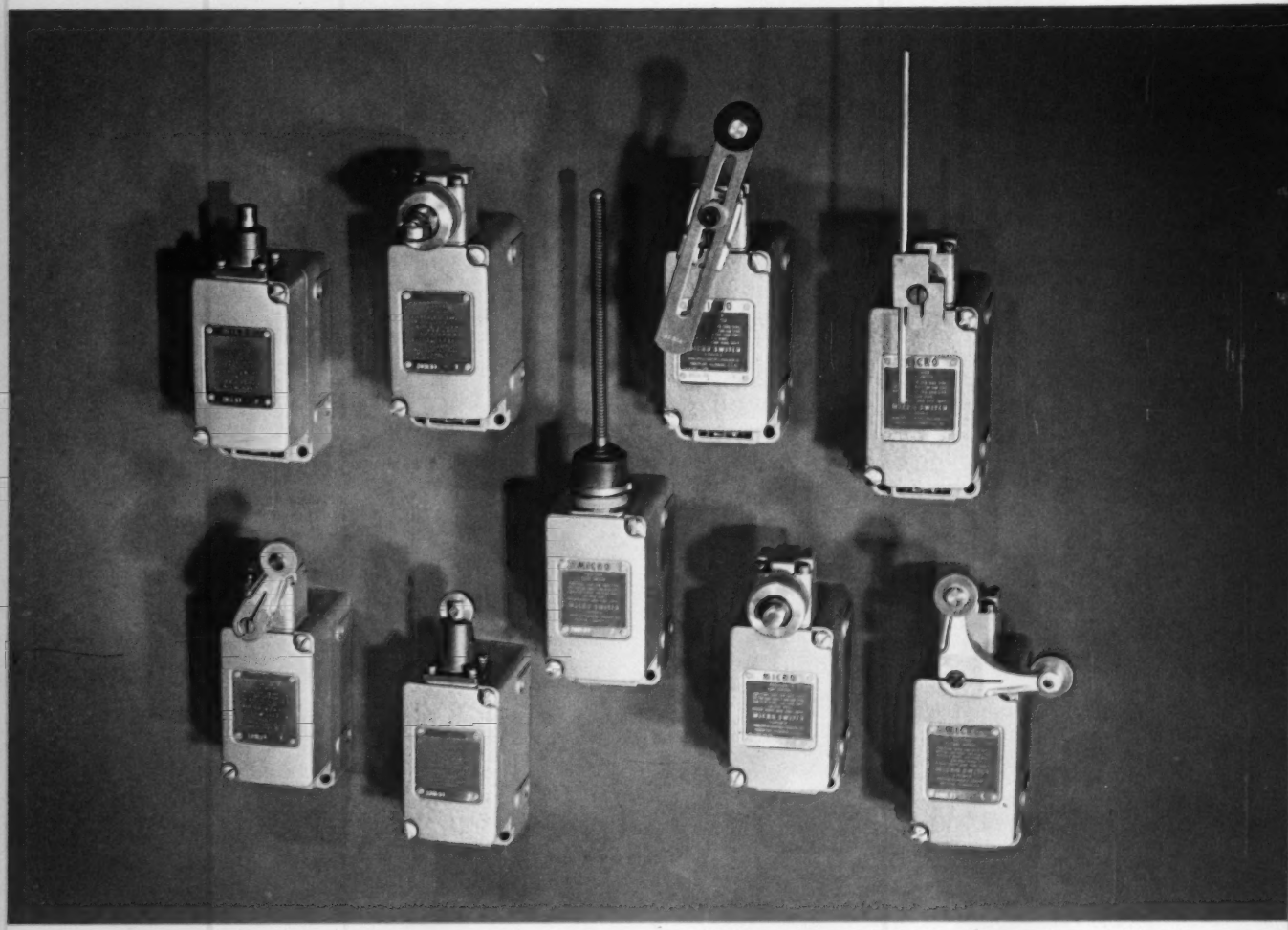
Honeywell

MICRO SWITCH Precision Switches

HONEYWELL INTERNATIONAL

Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

MICRO SWITCH Precision Switches



Cut downtime to 20 seconds with

MICRO SWITCH "Plug-in Limit" Switches

The terminal block, permanently mounted, has no parts to wear out. The actuator-switch assembly plugs in like a radio tube.

The oil and liquid-tight seals and the wear resistant qualities of "200LS" snap-action limit switches make them ideal for use as dependable long-life safeties, limits and interlocks in the most severe industrial applications.

Spring plugs integrally molded into the precision snap-action basic switch in the actuator assembly plug into the integrally molded terminal receptacle. Two captive screws and a ring gasket seal the two units together.

Nine standard and many special actuators are available. The basic switches are two-circuit double break. Actuator heads are adjustable to four positions and the terminal blocks may be mounted from the side or back, providing extreme versatility for changing production requirements.

For further information, see the Yellow Pages for the nearest MICRO SWITCH branch office or distributor or write for Catalog 84.

MICRO SWITCH . . . FREEPORT, ILLINOIS . . . A division of Honeywell

In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

HONEYWELL INTERNATIONAL

Sales and service offices in all principal cities of the world. Manufacturing in the United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Honeywell

MICRO SWITCH Precision Switches

one-sixth as much as copper and one-fourth as much as steel, and permits prefabrication of complicated process piping systems. It can be cut with an ordinary saw, curved with heat to practically any shape, is easily connected by solvent-cementing, heat welding, or threaded couplings. The pipe comes in ½ through 6-inch sizes in schedule 40 and schedule 80.

RANDOM ACCESS storage equipment which uses magnetic discs has been developed for Honeywell 400 medium-scale computers by Electronic Data Processing Div., Minneapolis-Honeywell Regulator Co. Capacity ranges from 24 million alphanumeric characters on a 6-disc unit to 96 million characters on a 24-disc unit. Average access time to any item in the file is approximately 100 milliseconds; maximum access time is 170 milliseconds. The random access unit controls all searching, reading, and recording operations on the entire disc file. It also controls all file switching, head selection, and information checking.

Information Service Offers Industrial Literature Searches

NEW Science Information Service (SIS), designed to aid industry and scientific institutions in implementing research and development projects has been established by the Technical Library of the Franklin Institute in Philadelphia. The service offers literature searches in any area of industrial processing, mathematics, engineering, physics, and chemistry. Resources include more than 200,000 reference volumes. Other reference sources include a collection of technical reports and nearly 5,000,000 patents from the U. S., Great Britain, and Canada, holdings of national and foreign abstracting services, and regular receipt of some 2500 scientific journals. The service of a number of science information specialists, including Ph.D's in chemistry and physics, as well as abstractors and translators in most languages have been secured by SIS.

Nitrogen Pipeline Under Construction

NITROGEN PIPELINE, approximately 22 miles long, will be installed by Air Reduction Co. Inc., to bring high purity nitrogen to plants in the Delaware Valley chemical complex. More than 100 tons of nitrogen per day will be piped to du Pont and Shell Chemical Co. plants at the ends of the T-shaped line. The pipeline will originate at Airco's new air separation plant at Claymont, Del., and cross the Delaware River into New Jersey. Total

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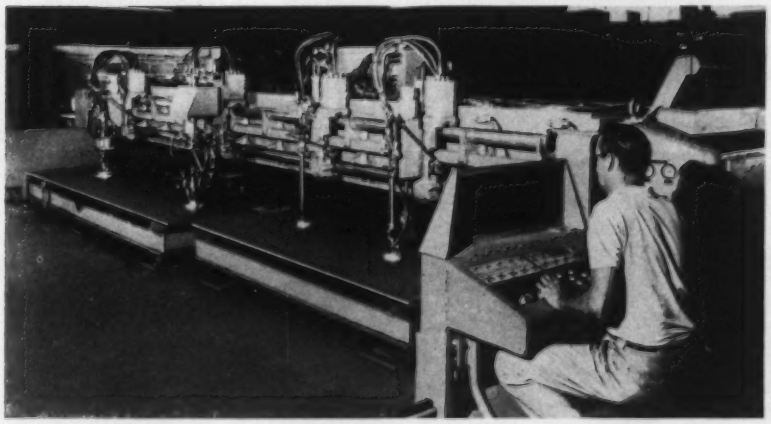
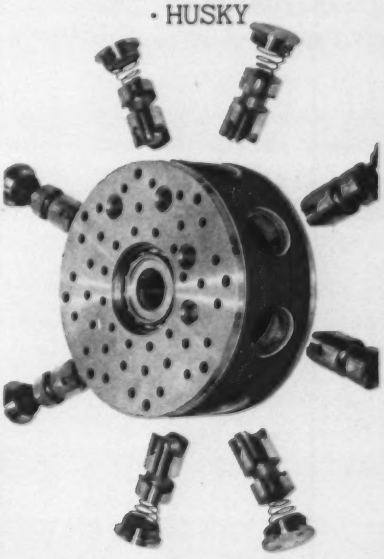


FLAME-CUTTING MACHINE controlled by punched tape is a bridge type unit capable of cutting straight lines and arcs of circles in plates up to 48 feet long, 22 ft wide, and 6 inches thick. Continuous two-axis control of the cutting path of the torches is provided as well as rotary positioning of bevel torches so that bevels are cut away from the part. Automatic compensation for flame width and control of speeds and gas flows are also included. Cutting speeds can be programmed within the limits of 2 ipm to 35 ipm, and fast traverse speed up to 150 ipm. The four-torch unit was developed by Air Reduction Sales Co. in cooperation with General Electric Co.

Servo motor ~~needed~~ Found

for radar, missiles, machine tools

· STIFF · RESPONSIVE
· HIGH TORQUE · EFFICIENT
· LOW PRESSURE
· HUSKY



Cimtrol's unique Acradrive 22 cu. in., 8 cylinder radial

Hydraulic Servo Motor

500 psi, 500 to 1/60,000 rpm, 22 cu. in./rev. displacement, 55 cu. in. contained oil, acceleration up to 40,000 radians per sec. per sec., $2,000 off the shelf, *now.*

Write for Bulletin M-2281G

Cimtrol Division
The Cincinnati Milling Machine Co.
Cincinnati 9, Ohio

CIMTROL

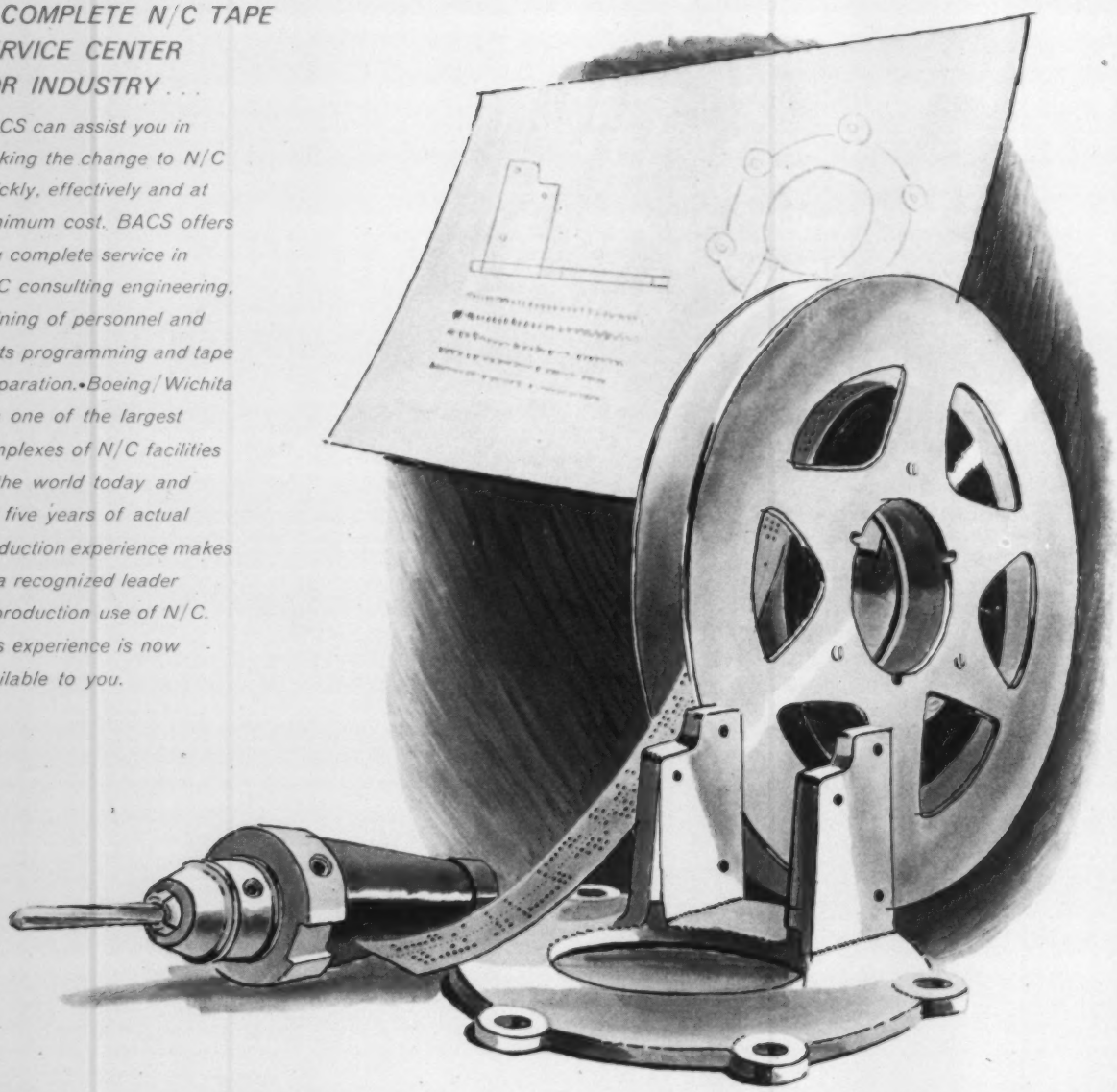
Circle 662 on Page 119

←Circle 661 on Page 119

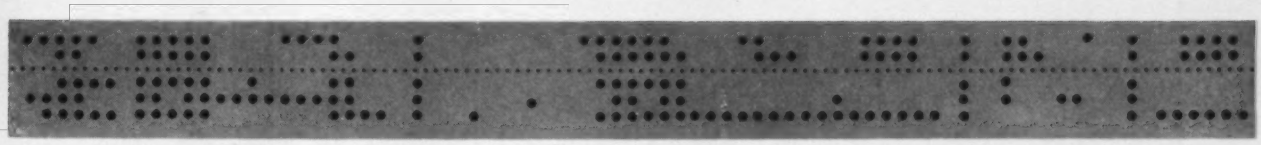
GET MORE PROFIT AND EFFIC
CONTROL PROGRAM WITH BOEING

A COMPLETE N/C TAPE SERVICE CENTER FOR INDUSTRY . . .

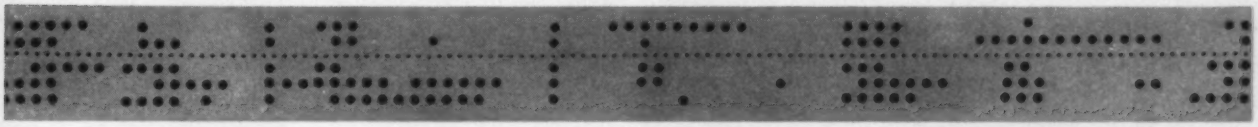
BACS can assist you in making the change to N/C quickly, effectively and at minimum cost. BACS offers you complete service in N/C consulting engineering, training of personnel and parts programming and tape preparation. Boeing/Wichita has one of the largest complexes of N/C facilities in the world today and our five years of actual production experience makes us a recognized leader in production use of N/C. This experience is now available to you.



BOEING



IENCY FROM YOUR NUMERICAL APPLIED COMPUTING SERVICES



HERE IS WHAT BACS OFFERS YOU

CONSULTING ENGINEERING: BACS consultants are experienced with all phases of manufacturing, types of machine tools and control systems, and specific training requirements. They will study your operation and submit definite recommendations to simplify your conversion to N/C. Examples of consulting services available are:

- Control System Application
- Data Transmission & Receival
- Numerical Control Machine Tool Selection and Application
- Control Systems
- Organization
- Systems Installation
- Computer Application
- Tool Design
- Linear Programming

TRAINING: Separate courses are available and can be conducted at Boeing/Wichita or at your plant if you prefer. All classes are conducted by professional instructors with broad backgrounds and experience in all phases of N/C. Courses available include:

- Milwaukee-Matic Computer Assisted Programming
- Management Orientation
- Maintenance Courses for Bendix, Numericord, Milwaukee-Matic, G.E. and J&L Control Systems
- 2-Dimensional and 3-Dimensional programming (only high school math required)

PARTS PROGRAMMING & TAPE PREPARATION: BACS supplies you with verified and guaranteed punched or magnetic tapes programmed from your drawings for Milwaukee-Matics or 2- and 3-D profiling. Several different checking systems prove a tape's accuracy, thus eliminating "dry runs" on expensive Numerically Controlled machine tools. BACS consultants will show you that you do not have to develop a computer program to utilize all the benefits of Numerically Controlled Machinery.

W. A. L. D. O. (Wichita Automatic Linear Data Output) WALDO is a production proven (4 years of actual operation) 2- and 3-D programming language. This highly sophisticated system offers three distinct advantages over other systems:

1. Only 33 words are used to describe any part or shape. (Most systems require over 100 words.)
2. You can upgrade present personnel. Only a background of high school math is needed to learn WALDO programming.
3. Less computer time than any comparable system. This means substantial savings for you.

Find Out How B A C S Can Assure The Success of Your N/C Program Write, wire or call collect, BOEING APPLIED COMPUTING SERVICES 2801 South Oliver • Wichita, Kansas • Dept. 119
MU 3-8511 • Ext. 3237

I would like more information about the following services:

- ☐ Consulting Engineering
- ☐ Training Courses
- ☐ Parts Programming & Tape Preparation
- ☐ W.A.L.D.O. (Wichita Automatic Linear Data Output)
- ☐ Please have your representative call

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

APPLIED COMPUTING SERVICES

Circle 663 on Page 119

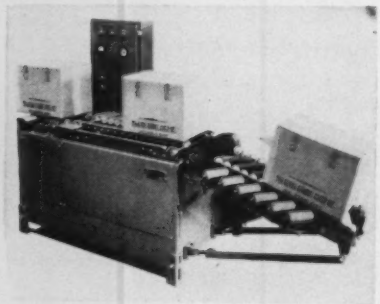
SELECTROL® Automatic CHECKWEIGHERS

Selectrol weighs in motion...eliminates manual spot checking

MODEL 1206

This Selectrol, Model 1206, automatically weighs, classifies and sorts packages or other items to 5 lbs. at speeds up to 120 items per minute, depending on size and weight. Rejection accuracy is 2/10 of one percent of the weight of the commodity at maximum speed. Tolerance limits are adjustable.

Selectrols are made by Exact Weight, a manufacturer of industrial scales for more than 45 years with experience gained through hundreds of checkweighing installations. For complete details on Selectrol Model 1206, write for Bulletin 3377.



CASE AND BAG CHECKWEIGHER

Model 1250 Selectrol automatic checkweigher is designed for checking bags, cartons and cases from 20 to 100 lbs. at speeds up to 30 items per minute. Accuracy is 1/10 of one percent at maximum speed. Can be supplied with or without rejection equipment. Request Bulletin 3376.

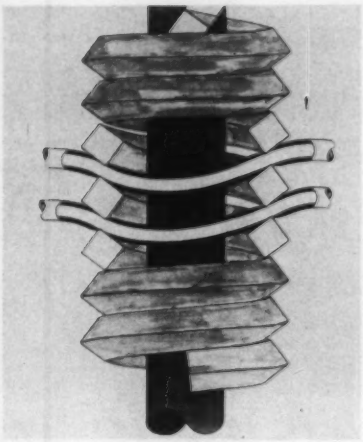
Exact Weight SCALES

THE EXACT WEIGHT SCALE CO.
907 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: 5 Six Points Road, Toronto 18, Ont.

Sales and Service Coast to Coast

Find us in your local "Yellow Pages"

BETTER QUALITY CONTROL . . . BETTER COST CONTROL



TERMINAL CONNECTOR, which resembles a coil spring, has been developed by Bell Telephone Laboratories. It is used to connect plastic-insulated small gage wires to terminal posts. The sharp edges of the square-shaped coil wire cut through the insulation of the telephone wire and make contacts which are electrically stable and vibration-proof. Wires can be inserted between other turns of the coil spring connector, and can be removed without disturbing other wires on the post.

capacity of the plant will be 750 tons per day of oxygen and nitrogen, plus 12 tons per day of argon.

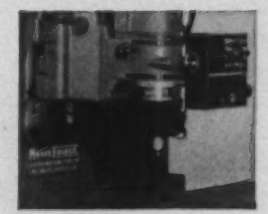
INFORMATION and computer system designed by Information Systems Inc. will be installed in the Tidewater-Collier Naphthalene Plant and will scan 300 temperatures, pressures, flows, and fluid levels with an expansion capability to 500 points. Process performance will be reported on through computer calculations of these variables. Information print-out will be provided for accounting purposes. Prime contractor for the plant construction project is the Catalytic Construction Co.

SPOTLIGHTING PEOPLE

Carl T. Zimmerman has begun work as an independent management consultant under his own name. . . . **Carl E. Anderson** elected president and chief executive officer of the E. W. Bliss Co. . . . **Robert L. Anderson** named project manager at Designers for Industry Inc. . . . **Gerald L. Phillippe** elected president and **Cramer W. LaPierre** elected executive vice president of

Circle 664 on Page 119

NUMERICAL CONTROL FOR PRODUCTIVE PRECISION BORING



Fosmatic numerical control is also available on Moore-Fosdick jig grinders.

FOSMATIC N/C PRECISION BORING MACHINES

Four models from the compact "32" with 18″ x 30″ table travel, to the big "54" with 28″ x 48″ travel. All available with Fosmatic electro-mechanical tape control for table position, spindle depth, head height, speeds, feeds, and tool changing. Fosmatic control positions workpieces accurately to ± .0001″. Fosmatic jig borers make provision for numerical control in the basic design and can be furnished in any degree of automation.

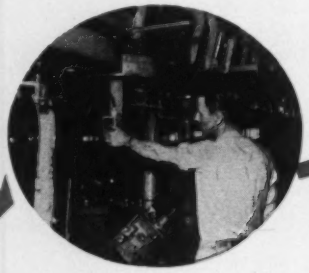
Get a proposal from

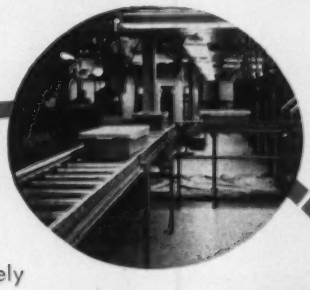
The Fosdick Machine Tool Co., Cincinnati 23, Ohio

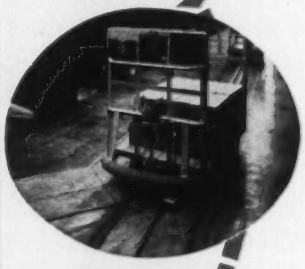
FOSDICK

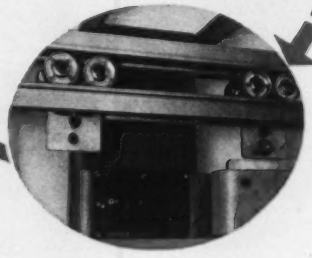
Circle 665 on Page 119

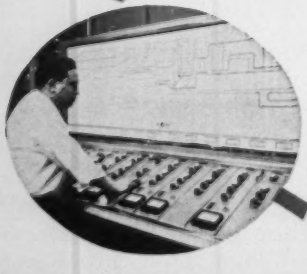
Controlling the movement in industry











For many years, Control Engineering Company has worked closely with conveyor equipment manufacturers. This close relationship has resulted in **system engineered** controls for specific applications. A CONTROLLED system will save on production costs, reduce lead time and increase handling efficiency.

Our complete line of **system engineered** controls, and our design experience — including modular construction, transistorized plug-in circuitry, feed back devices and servo devices — can be of help to you in planning your control systems.

Our CONTROL Engineers will be glad to consult with you on your particular **system engineering** problems.

Write today for free brochure describing our services.

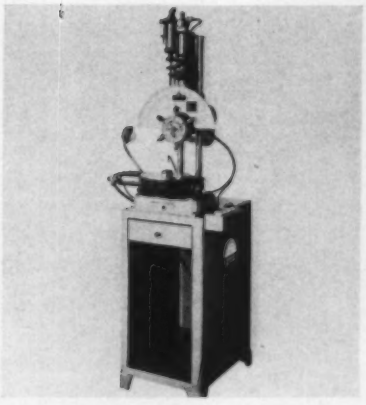
CONTROL ENGINEERING COMPANY

A SUBSIDIARY OF JERVIS B. WEBB COMPANY

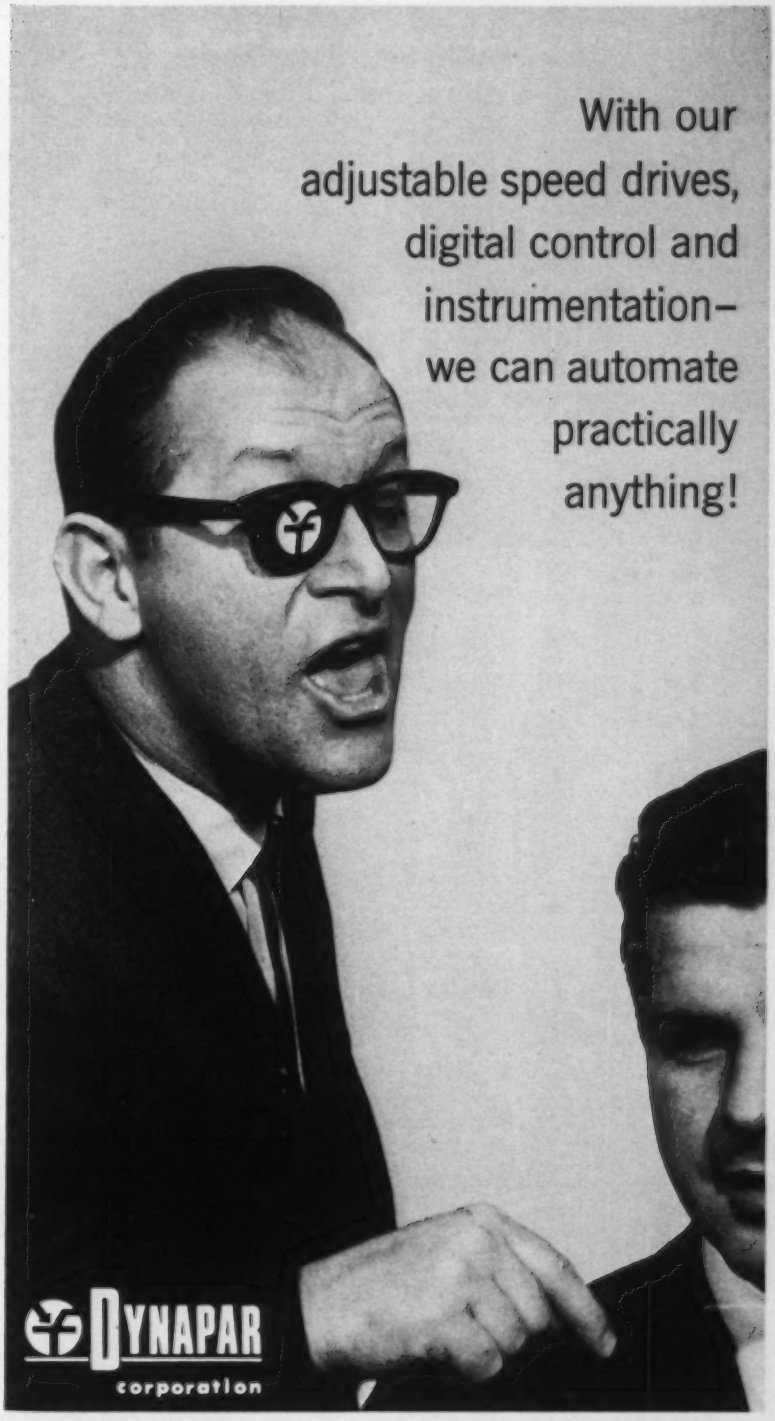
8007 Joy Road • Detroit 4, Michigan

Circle 666 on Page 119

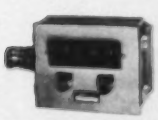
the General Electric Co. . . . **Maxwell B. Bassett** appointed vice president, systems management at General Precision Inc. . . . **Donald P. Caverly** elected vice president of General Time Corp. . . . **R. J. Render** appointed product planning manager of the Industrial Dept. at Vickers Inc., Div., Sperry Rand Corp. . . . **I. C. Maust** named vice president and general manager of Micrometrical Mfg. Co., subsidiary of Bendix Corp. . . . **Raymond S. Fries** appointed manager of manufacturing and engineering of Brown Instruments Div. and **Jay M. Bedrick** named manager of the electromechanical research and development department, Boston Div., both at Minneapolis-Honeywell Regulator Co. . . . **John F. Quereau** elected director and member of the executive committee at Leeds & Northrup Co. . . . **John V. Sutton** named division manager of the Packomatic Div., Textile Machine Works. . . . **William J. Pinkerton** elected president and general manager and **Ray W. Gauss** elected executive vice president and treasurer, both at Micromatic Hone Corp. . . . **E. E. Barone** named senior methods engineer at Fluid Controls Inc. . . . **Donald E. Sailer** appointed manager of manufacturing engineering for the Transducer Div., Consolidated Electrodynamics Corp. . . . **Andrew S. Huson** named assistant to the president at Benson-



RECIPROCATING FEED arrangement on bench model turret drilling machines provides for drilling of deep holes. Depth setting and rapid traverse are set on an electronic device to control the depth for each stroke and withdraw the drill any number of times to suit the work involved. Unit is available from Burgmaster Corp.



Dynapar is the electronic subsidiary of The Louis Allis Co. We make a full line of transistorized digital devices for high-speed counting, measuring, and control. Information on any of these products can be obtained from your local Louis Allis District Office — which is listed in The Yellow Pages under "Electric Motors."


Draw Indicators

Process Controllers

Rotopulsers

DD-223

DYNAPAR CORP., 463 E. STEWART ST., MILWAUKEE 1, WIS. *A subsidiary of The Louis Allis Co.*

Circle 667 on Page 119

Louis Allis engineered systems include:

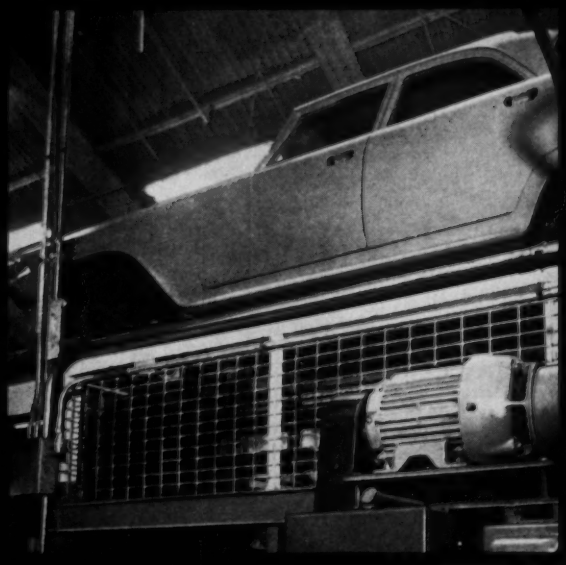
1. A Louis Allis drive powers this transfer table, shifts one body per minute into position for paint line after coming out of prime coat drying ovens.

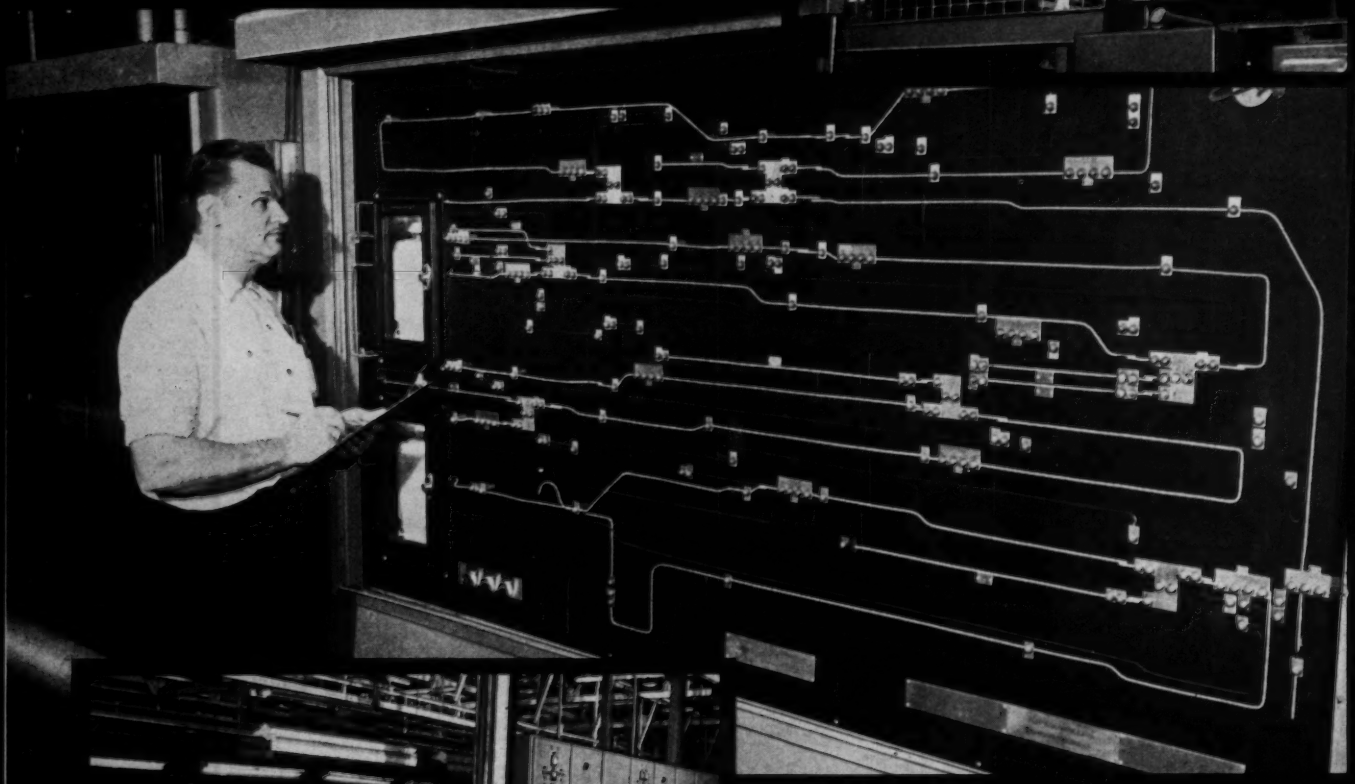
2. This 3 dimensional area control center monitors conveyor operations. Any type of production interruption is quickly revealed and identified by signal light indication. Recorders provide a permanent daily record of each conveyor's operation.

3. A bank of Louis Allis controllers regulate the drives powering the mating line where unitized body, stub frame/engine assembly and running gear are assembled. Here, a Plymouth convertible comes off the assembly line.

4. Louis Allis controllers coordinate the intricate assembly of side-gate framing fixtures and underbody just prior to welding. Three components arrive from three different locations at precisely the same moment.

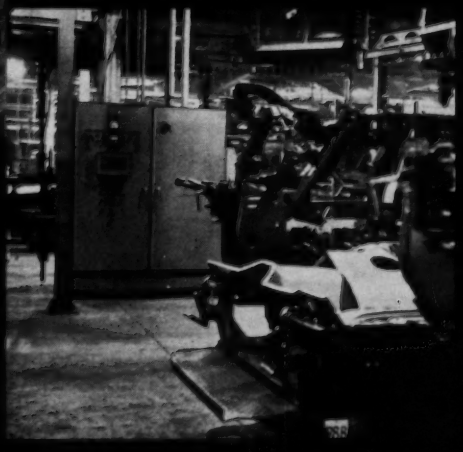
1. Automatic transfer station



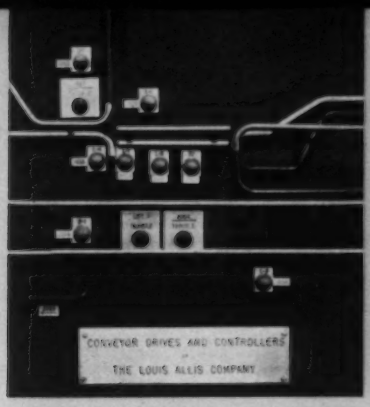


2. Area control center

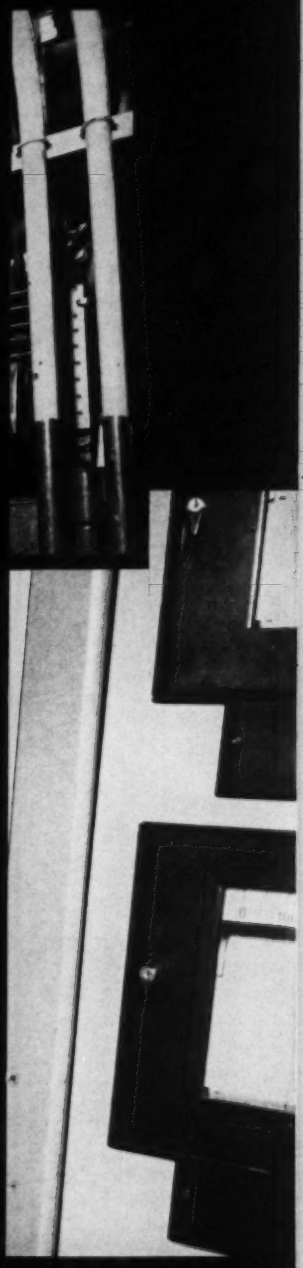
3. Pre-final assembly area



4. Initial body assembly



Engineering news from Louis Allis



LOUIS ALLIS engineered systems automate Chrysler assembly lines

An automobile assembly line is a materials handling complex of movement and synchronization. Feeder lines joining the main-line must deliver components on time — and in perfect synchronism. Still, the system must be flexible enough to accommodate speed changes when desired.

The Plymouth assembly plants in Detroit and St. Louis are models of this type of automation . . . and electrical components for the materials handling systems were custom-engineered by Louis Allis. L.A. systems engineers worked with Plymouth engineers to map the flow sequence. Louis Allis provided the adjustable speed drives and precision controls to operate the systems and supervised the installation. The result: integrated, automated systems that eliminate time loss, manpower waste, and excess materials handling costs.

Synchronized conveyors operate at pre-set speeds by following built-in master job-rate controllers. The system provides for automatic, position-perfect transfer of body components from one conveyor to another. A three-dimensional area control center monitors and records all conveyor operations.

If your plans call for automation, contact Louis Allis for systems engineering assistance — and single-source responsibility of drive and control design, manufacturing, and service. Call the Louis Allis District Office nearest you, or write to The Louis Allis Co., 463 E. Stewart St., Milwaukee 1, Wis. Ask for Bulletin 2900.

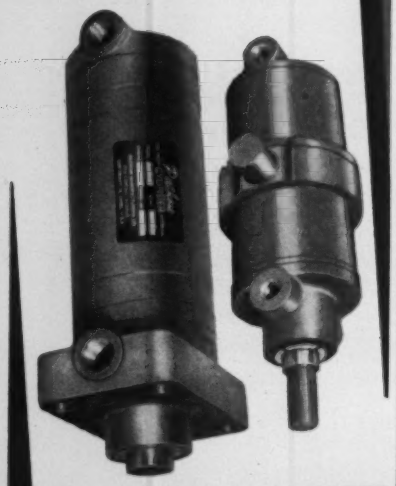
MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

ASD-237

Circle 668 on Page 119

Pathon Cylinders are most DEPENDABLE because

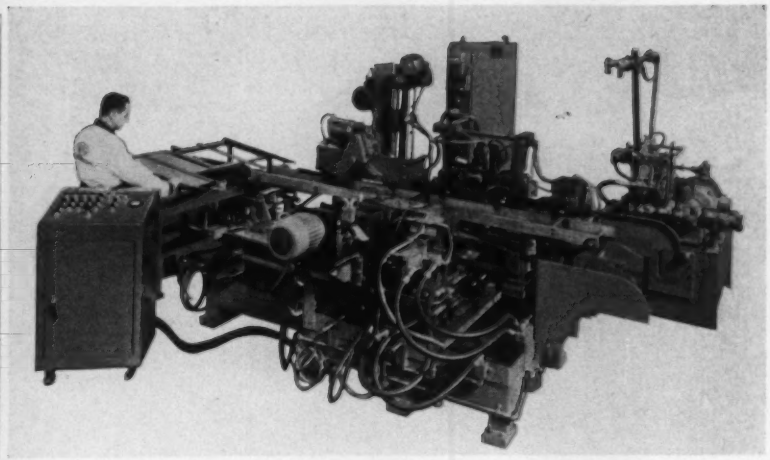


1. Screw thread heads to barrel attaching method gives maximum strength and requires minimum mounting area.
2. All mounting pads are integrally cast, and precision machined to assure greatest rigidity and perfect alignment.
3. Rod bearings, which are inboard of packing and pressure lubricated, provide longest possible service life.
4. Any wearing part can be replaced quickly, without complete disassembly.

Learn how dependable cylinders can be. Specify Pathon. A complete line of cylinders from 200 to 3000 P.S.I. Write for Catalog.

Pathon
MANUFACTURING COMPANY
3823 Pacific Avenue Cincinnati 12, Ohio

Circle 669 on Page 119



TUBES used in the fabrication of heating coils for electric ranges, are finished on a special machine built by Baird Machine Co. under contract to Varl Engineering Co. Machine automatically scratch brushes one end of tube, faces and chamfers both ends, sizes ID, forms simple heads on both ends, and flanges one end. Between 600 and 800 tubes are processed per hour.

Lehner Corp. . . . **James M. Black** appointed executive vice president of National Metal Trades Association. . . . **Edward E. Tschantz** named chief engineer of the Fastener Div., United Shoe Machinery Corp. . . . **Robert N. Wolfe** promoted to general manager of the Adhesives, Coatings, and Sealers Div., Minnesota Mining & Manufacturing Co. . . . **Arnold K. Weber** appointed staff vice president, manufacturing, of the Radio Corporation of America. . . . **Walter W. Kunde Jr.** named vice president-engineering of Dresser Electronics. . . . **Gary Himler** appointed director of engineering of Computer Measurements Co. . . . **Carl McKelvy** elected executive vice president of Royal McBee Corp. . . . **John R. Strom** promoted to vice president of both the Roto-Finish Co. and Ransohoff Co. . . . **Marcel Verrando** appointed chief engineer of Trinity Equipment Corp. . . . **Jerome L. Ross** promoted to general manager of the Meaker Co. . . . **Edward Bachorik** appointed executive vice president of Allied Control Co. Inc. . . . **Mark Shepherd Jr.** appointed executive vice president and **S. T. Harris** and **C. J. Thomsen** named senior vice presidents; all at Texas Instruments Inc. . . . **Harry V. Spence** appointed general manager-operations at Brooks Research Inc., subsidiary, Allerton Chemical Co. Inc. . . . **R. E. Clark** named manager of equipment engineering department, **J. K. Loeser** named manager of project engineering department, and **J. V. Werme** named manager of electrical engineering department, all at Bailey Meter Co.

SPOTLIGHTING PLANTS

Packaging Frontiers Inc., subsidiary, Bemis Bros. Bag Co. has completed a 10,000 sq ft building in Waltham, Mass. The new headquarters will serve as general and sales offices, customer technical service center, and research and development laboratory for the producers of the Ultra-Pak packaging system, a machine which forms, fills, and seals the package in one continuous operation. . . . **International Business Machines Corp.** has formed a Components Division to develop, manufacture, and purchase electronic components (including magnetic cores, diodes, and transistors) used in company data processing equipment. Headquarters are in Poughkeepsie, N. Y. . . . **Kaydon Engineering Corp.** has started a $1 million plant improvement program which includes a 15,000 sq ft plant addition. Other improvements include a rearranging of departments to improve work flow and minimize material handling; centralizing operations which are similar; and purchasing new machines and equipment. . . . **Atronic Products Inc.** has merged into General Atronics Corp. The name of Atronic Products will be

IT'S BOUND TO BE BETTER WITH USS STEEL STRAPPING

New Model 12 steel strapping machine prevents $1000 a week in shipping costs!

When the Castro regime banned the printing of *Time Magazine* in Cuba, W. R. Bean & Son, Inc. of Atlanta, Georgia, got the job. "We welcomed the new business but the shipping deadlines that came with it were almost impossible," says Vice-President W. R. Bean II. "In addition to our regular workload, we had to print and bind 92,000 copies of *Latin America Time* and *Bohemia Libre*, an anti-Castro weekly. To get the magazines to our distribution points on time, we frequently had to rush them by air, and each week it cost us $1000 more than our normal truck shipments. Our Model 12 steel strapping machine was binding more than its share but the workload was just too much. We needed another strapping machine fast."

A call to U. S. Steel Supply in Chicago brought a new Model 12 the very next day. W. R. Bean hasn't missed a deadline since. The two machines bind about 3000 various-sized bundles every week with 18½-gauge USS Round Steel Strapping. The tight, compact bundles have eliminated complaints that developed when the old rope-tied packages broke or worked loose before they reached destinations deep in the Latin American countries. Find out how the Model 12 can cut costs and speed production in *your* operation. Send the coupon.

U. S. Steel Supply
Division of
United States Steel

USS
TRADEMARK

U. S. Steel Supply
U. S. Steel Corporation
208 South LaSalle Street
Chicago 4, Illinois

☐ Please send me more information on the automatic Model 12 Strapping Machine.

☐ Please send me your Model 12 film, "Tie This."

Name_____

Company_____

Address_____

City_____ Zone____ State_____

Circle 670 on Page 119

your GAYLORD man is well-rounded in packaging

He has a quick, accurate answer to any question on corrugated packaging, from the design to the delivery of your product.

He makes it his business to understand every phase of packaging operations—box-making, printing, filling, closure, handling, shipping . . . the works. This way he makes sure your Gaylord containers perform most effectively and economically

Ask him one question or a dozen; he's as near as your telephone, right now.

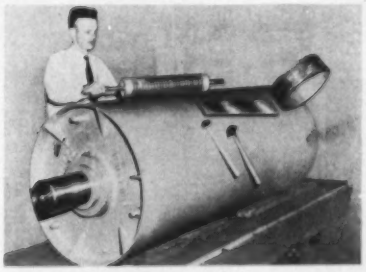
CROWN ZELLERBACH CORPORATION
GAYLORD CONTAINER DIVISION

IN CANADA · CROWN ZELLERBACH CANADA, LTD. VANCOUVER, B. C.

HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

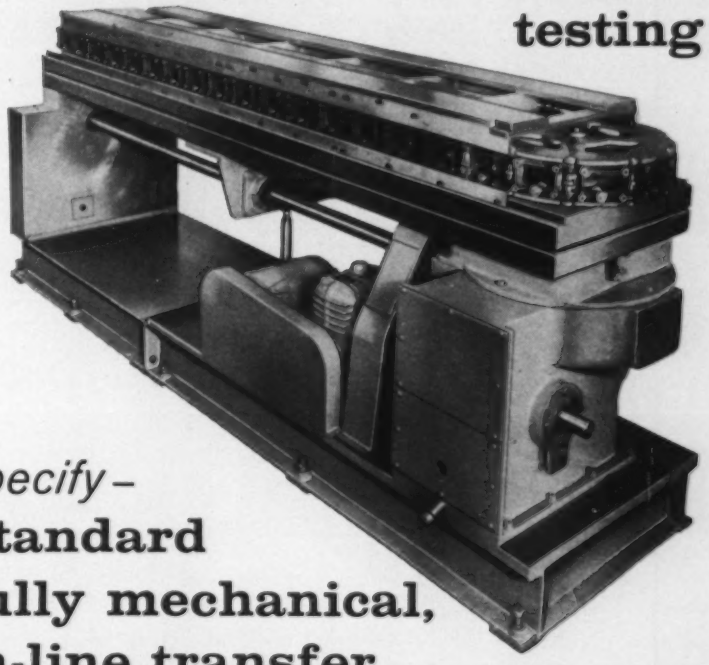
Circle 671 on Page 119

retained as a division of GAC. . . . **Mathews Conveyer Co.** has purchased the Wilkie Co., manufacturers of telescopic roller, wheel, and belt conveyors. It will be operated as a wholly-owned subsidiary of Mathews. . . . **American-Standard Controls Div.** has moved the manufacture of its TyniSwitch miniature snap switches from Stratford, Conn. to Rochester, N. Y. Production and engineering operations for the line of switches will be combined with its precision gage facilities. . . . **Carborundum Co.** has begun a $1½ million modernization and expansion plan for its Globar Electronics plant in Niagara Falls. The Globar plant project is to provide increased production capacity for present lines of non-metallic electric heating elements, resistors, thermistors, varistors, and electronic devices. . . . **Dynel Inc.** has moved into an 18,000 sq ft building in Los Angeles. The facilities will serve as a single source of supply for design, fabrication, and installation of remote monitoring and control systems for tanks and pipelines. . . . **Cleveland Crane & Engineering Co.** has established a west coast Tramrail Division with a plant at Los Angeles. The plant is equipped with engineering and shop facilities and standard equipment will be assembled and stocked. . . . **Victor Adding Machine Co.** and **Comptometer Corp.** have approved in principle a merger, subject to approval by the



MAGNETIC PULLEY weighs 3½ tons, is 30 inches in diameter. Nominated as world's largest permanent magnetic pulley, it was manufactured by Eriez Mfg. Co. for a sugar cane mill, and will be installed as the head pulley on an 82-inch wide belt conveyor which carries shredded sugar cane to a crusher. As cane is discharged from the conveyor, the magnetic field of the pulley will attract any tramp iron and hold it firmly to the conveyor belt. The iron will be carried around the pulley and discharged separately as it leaves the magnetic field.

for vital cost reductions in automatic assembly & testing



specify –

Standard fully mechanical, in-line transfer type, indexing unit–STA18

This is a precision transfer unit and machine base designed to be the main standard component in a wide range of automatic production and assembly machinery. It is self-contained and completely standard — ready for you to tool for your product.

The STA18 is available in 5 standard lengths, from 27 to 63 work carriers. It is fully mechanical. The main transfer drive is a cycloidal cam using 120° rotation for fast, smooth index and 240° rotation (dwell) for tool and work actuation. Transfer accuracy is within ±.003″.

Standard Tool also manufactures a complete line of cam operated Rotary Indexing Units . . . and other standard machine components.

The ST-A9AB for light to medium duty has 4 to 20 stations — with basic accuracy of ±.001 at 4″ radius and precision accuracy of ±.0005 at 6″ radius. The ST-A9B for heavy duty has 8 to 24 stations, with basic accuracy of ±.001″ at 7″ radius.

Write for bulletins No. 19 and No. 26 for complete engineering specifications.

MACHINERY DIVISION

Standard Tool & Manufacturing Co.

711 SCHUYLER AVENUE • LYNDHURST, NEW JERSEY

Better Products at Lower Cost through Better Methods

Circle 672 on Page 119

FORD

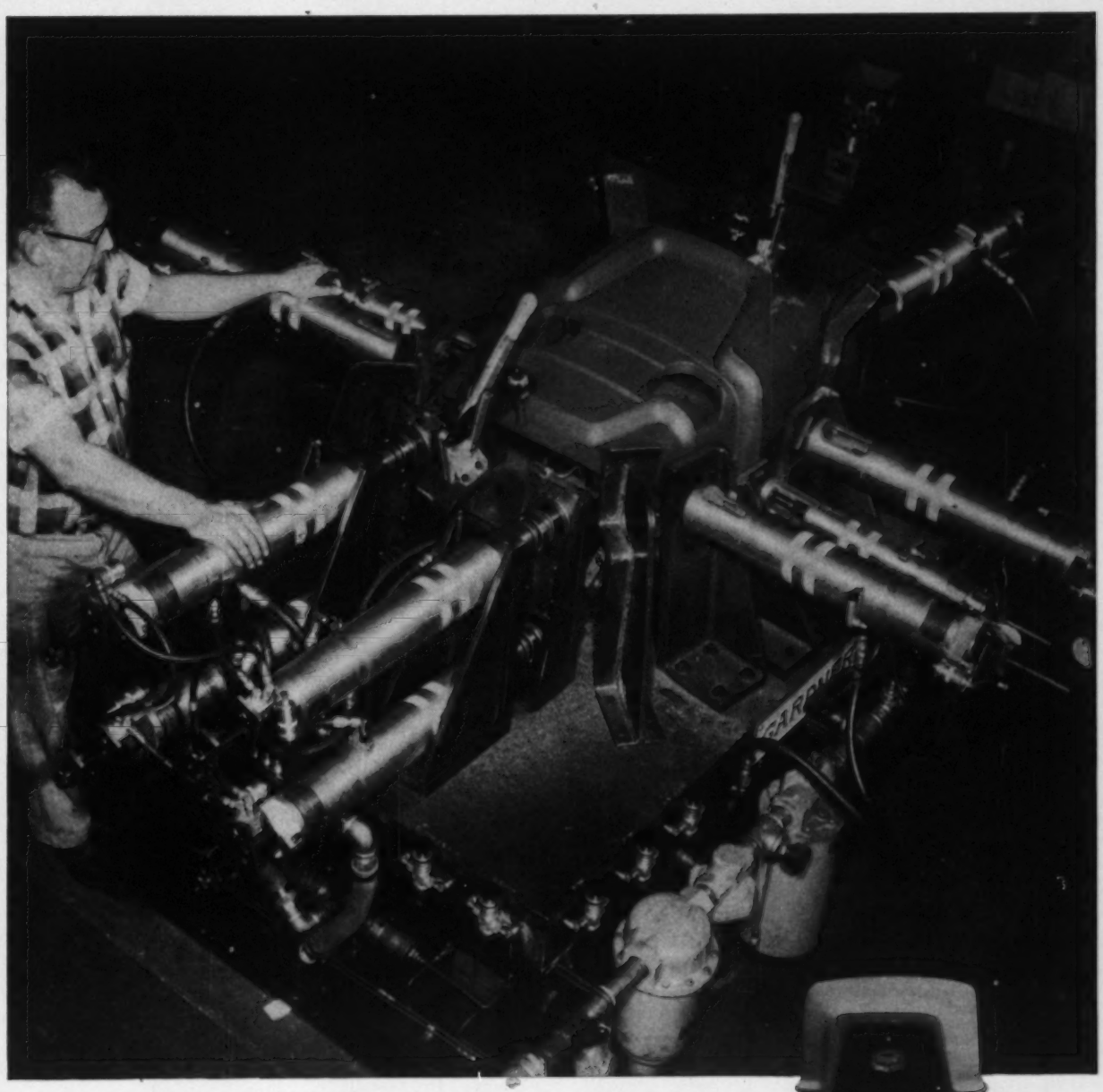
finds precision is automatic with this specially-designed air-powered machine

This Gardner-Denver automatic production drilling machine performs four precision operations on the front-end casting of new Ford 6000 tractors. It drills, spotfaces, counterbores and chamfers. Sizes range from a 7/16" drilled hole to a 2 5/8"-diameter spot-face.

Consisting of 12 "Airfeedrill"® units in various sizes, the machine drills 21 holes in each casting. Both stationary and portable "Airfeedrills" are used. Portables are moved from one fixed bushing to another to drill as many as three holes in a casting. Other drills have multiple drilling heads attached.

Parts are loaded in the machine with a Gardner-Denver air hoist. Air positioners accurately locate the casting from the inside, and hand clamps hold parts securely for drilling.

This is just one more example of how Gardner-Denver serves the ever-changing, ever-challenging needs of automated industry. Perhaps a Gardner-Denver air tools specialist can help you. Give him a call and see.



Specially-designed Gardner-Denver automatic production machine drills 21 holes in front-end casting of new Ford 6000 tractors. Also spot-faces, counterbores and chamfers.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

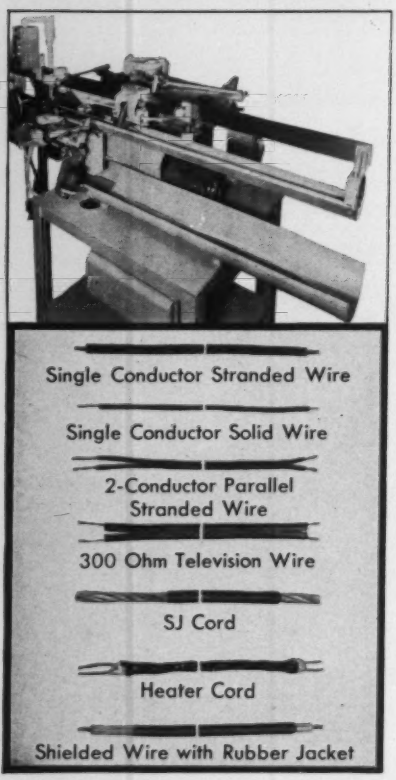
Gardner-Denver Company, Quincy, Illinois—Offices in principal U.S., Canadian and Mexican cities
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

International: Gardner-Denver International Division, 233 Broadway, New York 7, N.Y.
International Offices: Buenos Aires, Argentina; Artarmon, N.S.W. Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal

Circle 673 on Page 119

Another Time and Labor Saver

for finishing wire leads with ARTOS AUTOMATIC CS-6



A new collecting device is now available for use on the popular Artos CS-6 wire-measuring, cutting and stripping machine. Illustration shows the new collecting trough (AE-478). Upper trough collects wire leads up to 60 inches long, then empties into the lower trough after wire has been cut, thus saving operator time.

Production speeds of 3000 finished wire leads per hour up to 15 inches long. Maximum cutting length is 194 inches . . . stripping up to 2 inches at one or both ends. Artos also makes machines that measure, cut, strip and *attach terminals* automatically at one or both ends.

Operated by unskilled labor. Errors and work spoilage, due to human element, are eliminated. Machines are easily set up and adjusted for different lengths of wire and stripping.

Proved performance. Time-consuming hand stripping jobs which once were a bottleneck in many plants are gone forever. As a result, Artos automatic wire strippers are paying their way in the mass production of television and radio sets, electrical appliances, motor controls and instruments of all kinds.

If you need big capacity on wire lead finishing, WRITE for descriptive Artos Bulletin No. 36. Engineering consultation without obligation.

AGENTS THROUGHOUT THE WORLD

World Leaders in Automatic Machines for Finishing Wire Leads

ARTOS ENGINEERING CO.

2785 South 28th Street • Milwaukee 46, Wisconsin

IMPROVED WIRING method for electrical and electronic equipment has been developed by Sanders Associates Inc. Patent has been granted for wiring which consists of custom-etched designs of thin, flat conductors permanently bonded between and to flexible sheets of insulation. The thermoplastic base and cover are bonded to the conductors, providing a physical integration of the components and also protection against the penetration of moisture or gases. Only terminals are exposed, and these can be encapsulated after assembly.

stockholders. In the combination, the approximately 1,000,000 outstanding shares of Comptometer will become the same number of shares in the combined operation and the 1,000,000 outstanding shares of Victor stock will become 3,600,000 shares of the combined operation. . . . **Data System Div., Telex Inc.**, has acquired Inteledata Corp., for an undisclosed amount. It will add to the division's present line of mass memories, a line of medium and high speed line-at-a-time printers for computer output and communications applications. . . . **Photomation Inc.** has moved its executive, manufacturing, and engineering facilities to Mountain View, Calif. The new building occupies 10,000 sq ft of land area, with an additional 19,000 sq ft of landscaping and parking facilities. . . . **Racine Hydraulics & Machinery Inc.** has acquired an interest in Gettys Mfg. Co., manufacturers of electronic and electro-mechanical systems. Gettys will share responsibility in the designing, installation, and servicing of complete electro-hydraulic systems for Racine. . . . **Consolidated Vacuum Corp., subsidiary, CEC/Bell and Howell** have started a half-million dollar expansion program. Plans call for the addition of 23,000 sq ft for manufacturing and research, additional parking space, and the addition of a new road. . . . **Grieder Industries Inc.** has merged into Pines Engineering Co. Inc., with all

Circle 674 on Page 119

THE MILFORD RIVET & MACHINE CO.

the combination makes all the difference!

Milford specializes in both rivets and rivet setting machines. This benefits you in three ways:

1. Milford engineers help you determine not just a fastener, but the correct rivet for your assembly requirements. It may be semi-tubular, full tubular, split or compression; it may be a particular steel, brass, aluminum or alloy; it may be plain, plated, japanned or anodized.

2. The rivet setting machine and tooling recommended by Milford will be ideally matched to the parts to be assembled and specifically geared to the volume you run.

3. Get the combination that gives you lowest "in-place cost" — Milford rivets and Milford machines — for uninterrupted, quality production.

We'll be glad to quote on your needs immediately.

THE MILFORD RIVET & MACHINE CO.
MILFORD, CONNECTICUT • HATBORO, PENNA.
ELYRIA, OHIO • AURORA, ILL. • NORWALK, CALIF.

Circle 675 on Page 119

equipment and operations moved to the Pines site in Aurora, Ill. The Pines line of tube fabricating equipment will be broadened by the Grieder high speed tube cut-off machines, automation equipment, and special machinery. . . . **Hancock Telecontrol Corp.** has moved to new headquarters in New York City. Besides offices the new quarters provide areas to handle educational seminars with management and university consultants.

MEETINGS AND EVENTS

Oct. 4-6—

Process Industries Conference. To be sponsored by American Society of Mechanical Engineers at Shamrock Hilton Hotel, Houston. Information available from society headquarters, 345 East 47th St., New York 17, N. Y.

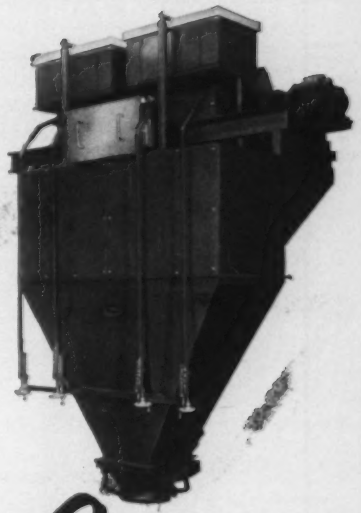
Oct. 9-11—

International Systems Meeting. To be held by Systems and Procedures Association at Pick-Carter Hotel and Statler-Hilton Hotel, Cleveland. Details available from association office, P. O. Box 6175, Cleveland 1, Ohio.

Oct. 9-11—

National Electronics Conference and Exhibition. Cosponsored by

TYPEWRITER-OPERATED paper tape preparation system offered by Invac Corp. uses photoelectric encoding techniques. Tapemaker consists of a manual or electric typewriter, a photoelectric encoder and a paper tape punch. The photoelectric encoder has a number of data light channels and associated binary-coded shutters. When a key is depressed, the corresponding shutter modulates the light channels according to the code of the particular shutter. Simultaneously, photocells at the end of each light channel transmit the binary-coded data to the paper tape punch.



One

THAYER SCALE PULLS LARGE FEED MILL OUT OF THE RED

Accuracy increased and handling costs reduced

Now ONE Thayer Bagging Scale does the same job that formerly required 3 conventional scales — and does it better. Weighing and bagging of feeds with different handling characteristics is automatically accomplished by simple adjustments on the Thayer Scale. The new, more accurate system has eliminated losses caused by overweight bags.

Unlike conventional scales, the Thayer Scale has no knife edge pivots to wear and cause inaccurate weighing. The Flexure-Plate suspension system of the Thayer Scale cannot wear, requires no maintenance, and accuracy is guaranteed for millions of weighings.

Call or write Thayer Scale for recommendations on improving or maintaining your competitive position through precise weight control.

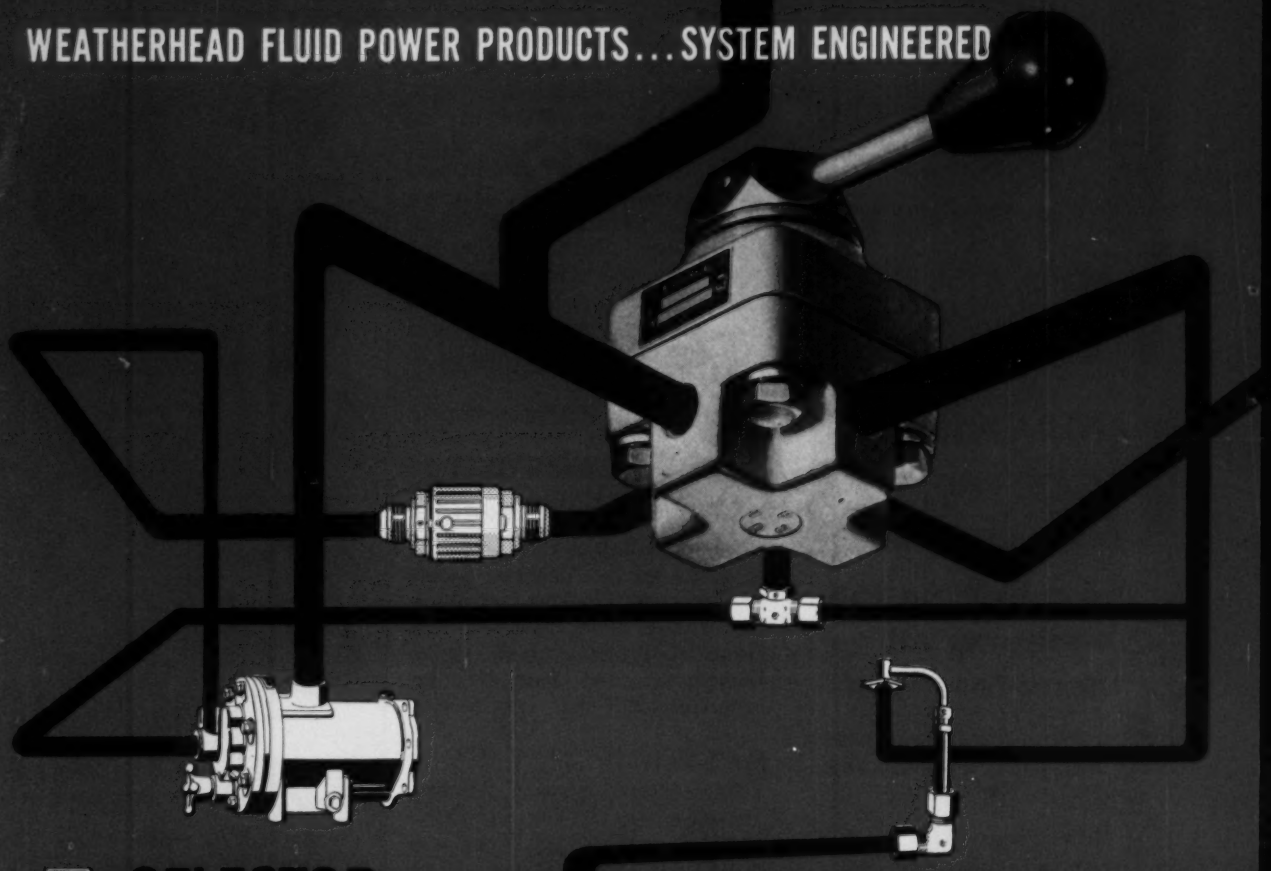
BAGGING, BATCHING, METERING, CHECKWEIGHING and CUSTOM DESIGNED SCALES.

THE Thayer SCALE

THAYER SCALE CORP.
5 Thayer Park
Pembroke, Massachusetts
TAylor 6-2371
A Subsidiary of Sundstrand Corporation

Circle 676 on Page 119

WEATHERHEAD FLUID POWER PRODUCTS... SYSTEM ENGINEERED



SELECTOR CONTROL VALVES STANDARDIZED FOR ECONOMY... ENGINEERED FOR VERSATILITY

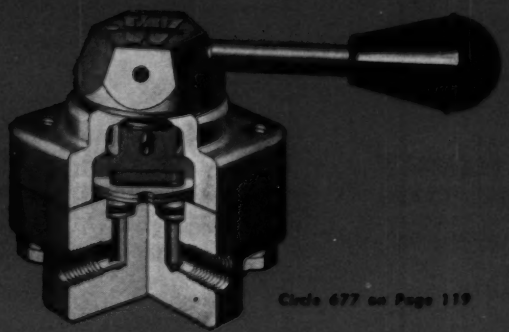
Unmatched economy is achieved by standardizing on a 4-way design, adaptable to 2 or 3-way selection. Greater versatility is provided because this advanced control monitors hydraulic or pneumatic flow pressures ranging from zero to 3000 psi.

These outstanding capabilities eliminate need for additional spare parts on intermediate pressure models . . . assure availability from distributor stock . . . simplify varied application needs over wide pressure range.

Weatherhead selector control valves offer: safe, smooth operation ■ positive sealing ■ spring centered, or detent position handles ■ horizontal or vertical ports ■ panel mounting or flexibility within the system.

Contact your nearby Weatherhead distributor or write direct for latest brochure.

THE WEATHERHEAD COMPANY
CLEVELAND 8, OHIO



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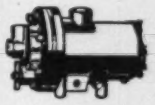
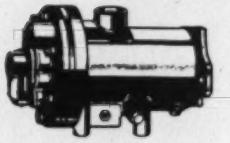
WEATHERHEAD
HYDRAULIC POWER
Components

VARIABLE DISPLACEMENT PUMPS

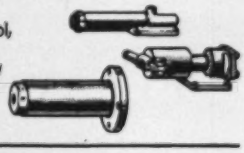




Meet J.I.C., S.A.E., and M.S. standards. Pressures to 3000 psi

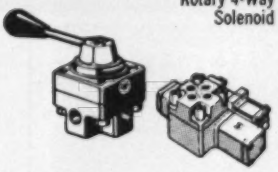
PUMP CONTROLS

Pressure Control, Automatic (Constant) Flow Control, Manual Displacement Control



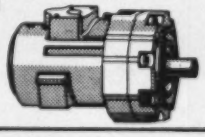
DIRECTIONAL CONTROLS

Rotary 4-Way Valves
Solenoid Valves



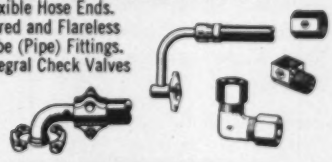
HYDRAULIC DRIVES

Fixed Displacement Hydraulic Motors, Reversible Variable Displacement Hydraulic Motors (Integrated Torque and Speed Control)



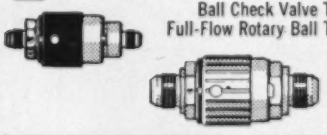
HIGH PRESSURE HOSE AND FITTINGS

Swaged, Crimped, and Field-Attachable Flexible Hose Ends. Flared and Flareless Tube (Pipe) Fittings. Integral Check Valves



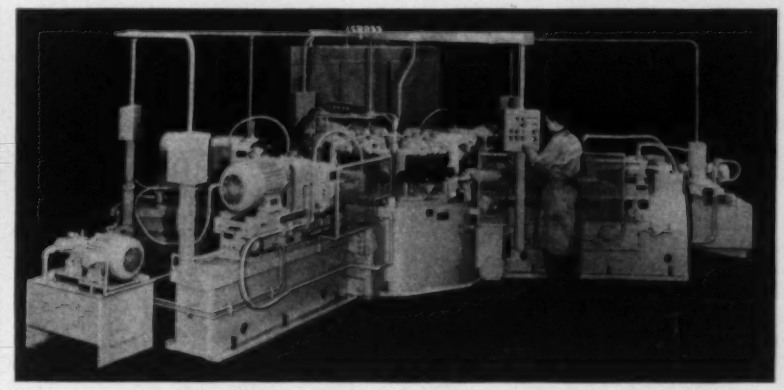
SELF-SEALING COUPLINGS

Ball Check Valve Type
Full-Flow Rotary Ball Type



THE WEATHERHEAD CO.
300 EAST 131 ST. • CLEVELAND 8, OHIO
Distributors in all major markets

Circle 677 on Page 119



DIAL-TYPE machine uses strip broaching in place of reaming to process wrist-pin holes in connecting rods and ready them for bushing assembly. It was found that broaches stay sharp longer and a better finish is achieved with less tool maintenance. Also, the longitudinal marks left by the broach provide a good seat for the wrist-pin bushing. A production rate of over 500 connecting rods per hour with 80 per cent efficiency is achieved, and a finished-hole tolerance of ±0.0007-inch is maintained. The six station machine developed by Cross Co. drills, core drills, and chamfers the holes before broaching and ball burnishing them.

AIEE, IRE, Illinois Institute of Technology, Northwestern University, and the University of Illinois. To be held at the International Amphitheatre, Chicago. Further details available from NEC headquarters, 228 N. LaSalle St., Chicago 1, Ill.

Oct. 9-13—

Aerospace Engineering and Manufacturing Meeting. Meeting and engineering display to be sponsored by Society of Automotive Engineers at Ambassador Hotel, Los Angeles. Details available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Oct. 10-11—

American Society of Tool and Manufacturing Engineers. Seminar on manufacturing with space age metals to be held Sheraton Hotel, Philadelphia. Information available from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Oct. 15-19—

Technical Association of the Pulp and Paper Industry. Engineering conference to be held Shoreham Hotel, Washington, D. C. Additional information available from association headquarters, 360 Lexington Ave., New York, N. Y.

Oct. 16-18—

American Institute of Electrical Engineers. Machine tools conference to be held Faust Hotel, Rockford, Ill. Details available from institute headquarters, 33 West 39th St., New York 18, N. Y.

Oct. 17-18—

American Society of Mechanical Engineers. Bulk solid handling symposium, sponsored by the Materials Handling Division of ASME, to be held at Pick Nicollet Hotel, Minneapolis. Additional information available from society headquarters, 345 East 47th St., New York 17, N. Y.

Oct. 18-20—

Packaging Institute. Annual packaging forum to be held Biltmore Hotel, New York. More information available from institute headquarters, 342 Madison Ave., New York 17, N. Y.

Oct. 19-20—

National Conference on Industrial Hydraulics. Conference on fundamental and applied industrial hydraulics to be held Sherman Hotel, Chicago. Details available from W. R. Smith, Illinois Institute of Technology, 35 West 33rd St., Chicago 16, Ill.

Oct. 23-27—

American Society for Metals. National metal congress and exposition to be held Cobo Hall, Detroit. More details available from society headquarters, Metals Park, Novelty, Ohio.

Oct. 25-26—

Computer Applications Symposium. Sponsored by Armour Research

if you're thinking of using the newest screw-type fasteners...

APEX Power Bits for SOCKET HEAD screws (Allen type)

TYPE OF SHANK	HEX SIZE Nominal	HEX SIZE Actual	TO BE USED IN Socket Head Cap Screw	TO BE USED IN Socket Set Screw	Overall Length	Part Number
1/4" HEXAGON DRIVE	1/16	.062	#1	5 & 6	1-15/16	AM-02
	5/64	.077	#2, #3	8	1-15/16	AM-02A
	3/32	.092	#4, #5, #6	#10	1-15/16	AM-03
	7/64	.108	#6	—	1-15/16	AM-03A
	1/8	.124	#8	1/4	1-15/16	AM-04
	9/64	.139	#8	—	1-15/16	AM-04A
	5/32	.155	#10	5/16	1-15/16	AM-05
	3/16	.186	1/4	3/8	1-15/16	AM-06
	7/32	.217	5/16	7/16	1-15/16	AM-07
	1/4	.249	—	1/2	1-15/16	AM-08
5/16" HEXAGON DRIVE	1/8	.124	#8	1/4	3	AS-04
			#10	5/16	3	AS-05
						AS-06
						AS-07
						AS-08
						AS-10
	3/8	.374				AS-12
7/16" HEXAGON DRIVE	1/8	.124	#8	1/4	3-1/2	AN-04
	9/64	.139	#8	—	3-1/2	AN-04A
	5/32	.155	#10	5/16	3-1/2	AN-05
	3/16	.186	1/4	3/8	3-1/2	AN-06
	7/32	.217	5/16	7/16	3-1/2	AN-07
	1/4	.249	—	1/2	3-1/2	AN-08
				5/8	3-1/2	AN-10
						2
						6
						18
						0
						12
						16
						18
						20
	3/8					
	1/2	.498				
	9/16	.560				
	5/8	.623				

Insert and power bits to drive the new 7/64" and 9/64" hex sizes have been added to the complete range of Apex tools to drive socket head screws, 1/16" to 5/8" hex sizes.

...the tools you'll need to drive them are already in stock— at Apex!

Cap screw sizes shown in color are new 1960 standards dimensions.

We quote promptly on specials.

If you're driving thousands of screws a day, or just a few . . . if you use several types and sizes of screws or just one . . . Apex has the screwdriving tools to help you save time and money. All standard types and sizes in stock . . . specials get "special" attention! For complete information, write for your copy of the new Catalog 30-C.

APEX FASTENING TOOLS

SCREWDRIVING • NUT RUNNING • SPECIAL

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Foundation and scheduled for Morrison Hotel, Chicago. Information available from Benjamin Mittman, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 26-27—

American Society of Tool and Manufacturing Engineers. Semi-annual engineering conference to be held Royal York Hotel, Toronto, Canada. Additional information available from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Nov. 1-2—

American Society of Mechanical Engineers. Textile Engineering Division Conference will discuss Automation and its Potential for the Textile Industry. To be held at the Little Theatre, Kresge Auditorium, Massachusetts Institute of Technology, Cambridge, Mass. Additional information available from society headquarters, 345 East 47th St., New York 17, N. Y.

Nov. 1-3—

Industrial Management Society. Industrial engineering and management clinic to be held at the Pick-Congress Hotel, Chicago. More details available from society headquarters, 330 South Wells St., Chicago 6, Ill.

Nov. 7-10—

Packaging Machinery Manufacturers Institute Show. Conference and exhibit to be held Cobo Hall, Detroit. Additional information available from Hanson & Shea Inc., One Gateway Center, Pittsburgh 22, Pa.

"Yes sir! We know these control panels inside and out."

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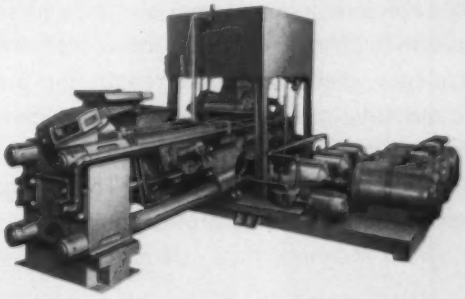
SPO-MILWAUKEE BRIQUETTING PRESS!

Here's the smart way to turn those mountains of chips, turnings and borings into higher valued scrap that will result in greater profits.

Naturally . . . briquetted scrap is easier to handle and a lot cheaper to transport . . . requires minimum storage area and facilitates faster disposal. RESULT? . . . PROFIT!

Investigate the advantage of installing a SPO-MILWAUKEE BRIQUETTING PRESS today. Ask yourself these questions . . . *Does our machine tool scrap output range from four-tons per day to 9-tons per hour?* . . . Do we want to turn a problem into a profit? It's possible you can answer both questions and solve related problems with a SPO-MILWAUKEE Briquetting Press.



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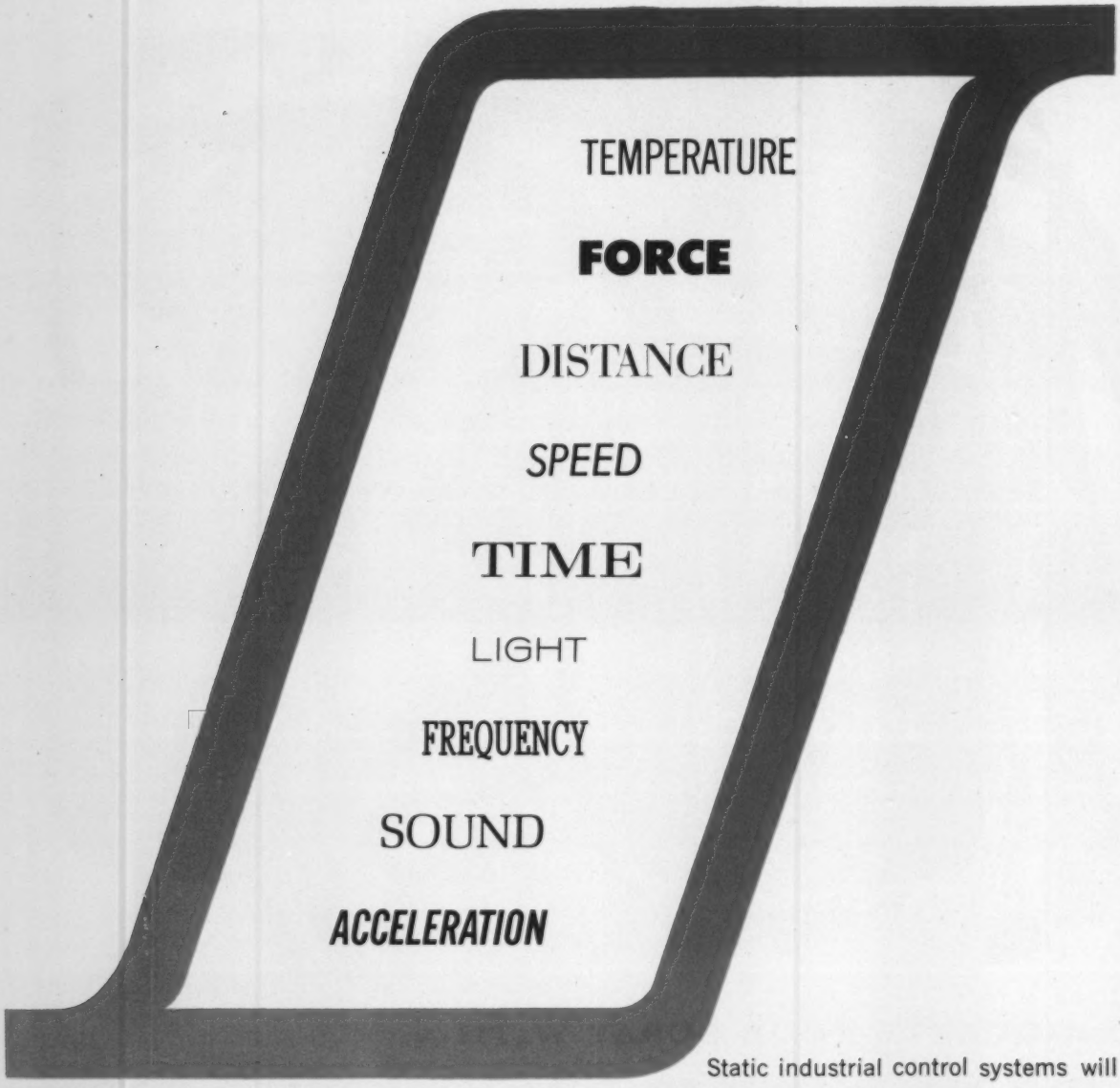
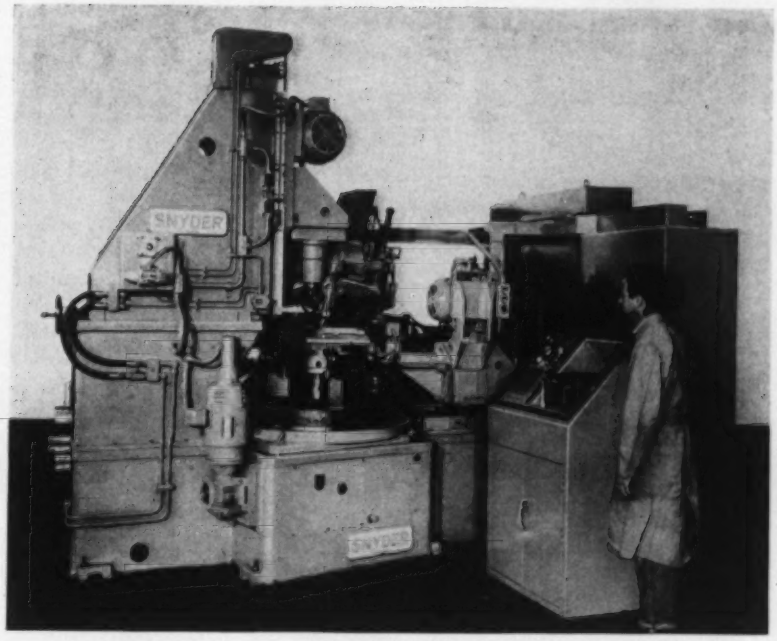


Static industrial control systems will regulate virtually anything that is controllable – and under normal operation these *magnetic* systems will never break down, wear out or need servicing. Temperature (with precision to ±1/4°F at 2200°), position (with logic involving *and, or, not, memory* and *time delay),* speed, force, light, sound, acceleration, frequency, distance, field strength and pressure are but a few. ■ One manufacturer has replaced a vacuum tube-mechanical relay system on his high-speed assembly lines. Reason: it broke down every three weeks. The replacement magnetic static control system has now gone through 26,000,000 consecutive cycles without fault. ■ The symbol above, the magnetic hysteresis loop, ⎍, may encompass some of your control problems which are solvable at a lower overall cost. May we discuss this with you? Magnetics Inc., Department A-93, Butler, Pennsylvania.

INDUSTRIAL CONTROL EQUIPMENT

MAGNETICS inc.®

By LEE D. MILLER, Associate Editor



Tape controlled machine applies numerical control to the production of cast iron diesel engine flywheels. The dial-type, multihead, special machine tool was built to drill, ream, and counterbore different hole patterns in a variety of workpieces. The punched tape controls indexing of the table to proper position and initiates automatic feed cycles of the four machining units located around the table.

A Time for Twists

IF THE OPTIMISTS of autodom are to be pleased, large segments of the car buying public should now be or should soon be ready to turn a key in a 1962 model. To satisfy all who so desire to twist their wrist, the production methods and equipment to put the enticing merchandise before the consumer are already facing the acid test on the production lines. These manufacturing means must reliably and economically perform the desired functions to produce the gleaming beauties for the sales floors.

Besides supplying bug eradication efforts for the buildup, practitioners of the manufacturing engineering arts must currently, and continually, be searching for new twists in methods and equipment. In the American version of flow lines to the final user, the members of one manufacturing engineering team must continually seek production improvements simply because competitive teams are too. If one team fails to keep improving their methods, the competitive team that does improve methods will wind up with more of the marbles.

Other groups applying pressures in the same direction include the United Auto Workers. Their recent activities in arm twisting make increased labor cost a further factor in the manufacturing money equation. There is a proposition that the prospective customer's eagerness to turn the key in a new car is inversely related to the wringing effect on his pocketbook. This effect combined with the none-too-delicate pressures from Washington point to increased emphasis on improved production means.

A Pneumatic Twist

An interesting development for measuring small holes in automobile carburetors involves a neat twist in design of an air gaging system. Taft-Peirce Mfg. Co. has developed an instrument that makes the part to be checked an integral element of an air gaging system. Carburetor jets with very fine holes are involved, and each hole has to be gaged to very close tolerances. The holes are too small for use of ordinary plug gages or air plugs.

Using special fixtures, the workpieces are mounted so that each hole to be gaged can be precisely positioned in relation to an opposing surface. A stream of air is sent through the hole, and measurement of the air velocity readily determines whether or not the opening is within tolerance.

The principle has also been applied in the electronics industry to position parts of cathode ray guns within the necks of TV and oscilloscope tubes. In this application, perforated discs must be inserted at a precise distance from the tube face plate. Using the holes in the disc as escape nozzles, the distance is accurately measured by a conventional air gage.

A Holey Weapon

It's true that numerical control may not be appropriate for many of the operations associated with Detroit production. However, evidence is being generated to show that not as many operations are outside its sphere as may have been supposed.

For example, punched tape is the control medium for a special machine recently built by Snyder Corp. to drill, ream, and counterbore holes in diesel engine flywheels (see lead photograph). An assortment of cast iron flywheels with a variety of diameters, axial lengths, hole sizes, and hole patterns are processed on the tape-controlled machine.

Workpieces are held in the machine on a dial index table 34 inches in diameter. For the flywheel

job four machining units are positioned around the table—one vertical, two horizontal, and one mounted at an angle. The punched tape is fed to a Mark I numerical control system built by General Electric Co. This system controls the indexing of the table to proper position and initiates automatic feed cycles for the machining units.

The dial indexing system is a major feature of the unit. The table can be indexed at a rate of 2 rpm and attains spacing accuracy of plus or minus 0.0005 inch on a 32-inch diameter. No shot pins or braking devices are used on the index table. Positioning is accomplished by a unique worm drive system in combination with a synchro arrangement that provides signals indicating actual position of the table. The drive train includes an amplidyne motor, a double enveloping worm gear reduction, a set of spiral bevel gears, two double-enveloping non-reversing worms, and a worm wheel.

The worm wheel is attached to the underside of the index table and driven by the two worms. They contact the wheel in locations at 90-degrees to each other and provide an adjustable, no-backlash drive. A precision fine pitch instrument gear 32 inches in diameter is also attached to the table. It drives the feedback selsyn.

Based on the instructions from the tape and the signals from the synchro, the drive motor is slowed as the desired table position is approached, and the motor is stopped when the position is reached. The non-reversing worm gear drive stops the table in correct radial location with an action that resembles the seating of a shot pin.

This application of numerical control does not illustrate the most complex use of this technique. Even in the automobile business, for instance, numerical control on general purpose machine tools has been applied to die-sinking operations involving more complex cycles. But this application is one example of the use of the numerical control method for day-to-day manufacture of production parts that are close relatives to those found in automobiles.

A Mechanical Twist

Possibly it might be considered as the opposite end of the control spectrum, but a mechanical control twist was recently applied to a metal cutting problem in another area. The direct mechanical control feature was provided in a machine supplied by Ex-Cell-O Corp. to simultaneously turn an elliptic form and a cylindrical form on aluminum pistons.

The combination turning job is performed on a single-end boring machine having two spindles and using special drum cams and tooling (see second illustration). The periphery of each cam is ground to the elliptic form desired on the piston skirt. A cam is mounted with the work-holding fixture on each spindle. Two tools are provided on the machine table for each spindle.

A piston loaded on a given spindle is worked on simultaneously by the two tools for that spindle. The tool which turns the elliptic skirt of the piston is mounted in a spring loaded tool block which also carries a cam follower. Contact of the follower with the cam moves the tool in and out to form the desired elliptic form as the machine table feeds away from the spindle head.

At the same time, the other tool for that spindle, after being fed to depth, maintains its position as the table feeds it along the work. This tool turns a true diameter to finish the ring lands on the piston. Tolerances are held within 0.001 inch on ring land diameter and within 0.0003 inch TIR on elliptic form.

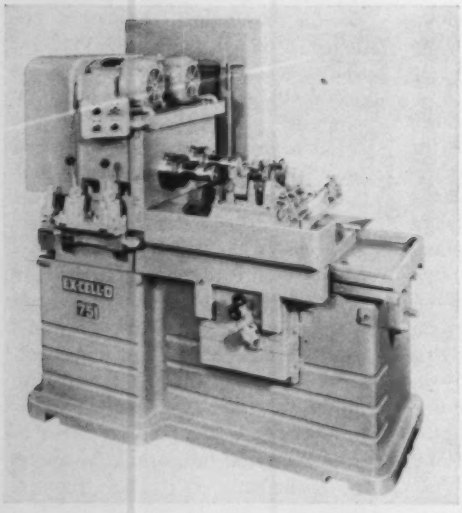
It seems appropriate to occasionally take note of simple mechanical means to automatically accomplish a production task. Such means deserve a prominent place in every manufacturing team's storehouse of ideas for doing a job. Though the glamour of more complicated and sophisticated - appearing methods may overshadow the simple approach, the cost of glamour for glamour's sake is usually difficult to justify.

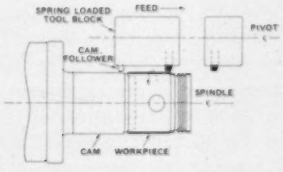
Broad Technology

It's not a new idea to automatically form a non-circular cross section on a rotating workpiece by use of a cam that controls the position of a cutting device relative to the work. The same principle has been applied for many years to the generation of certain types of wood products by use of rotating cutter heads.

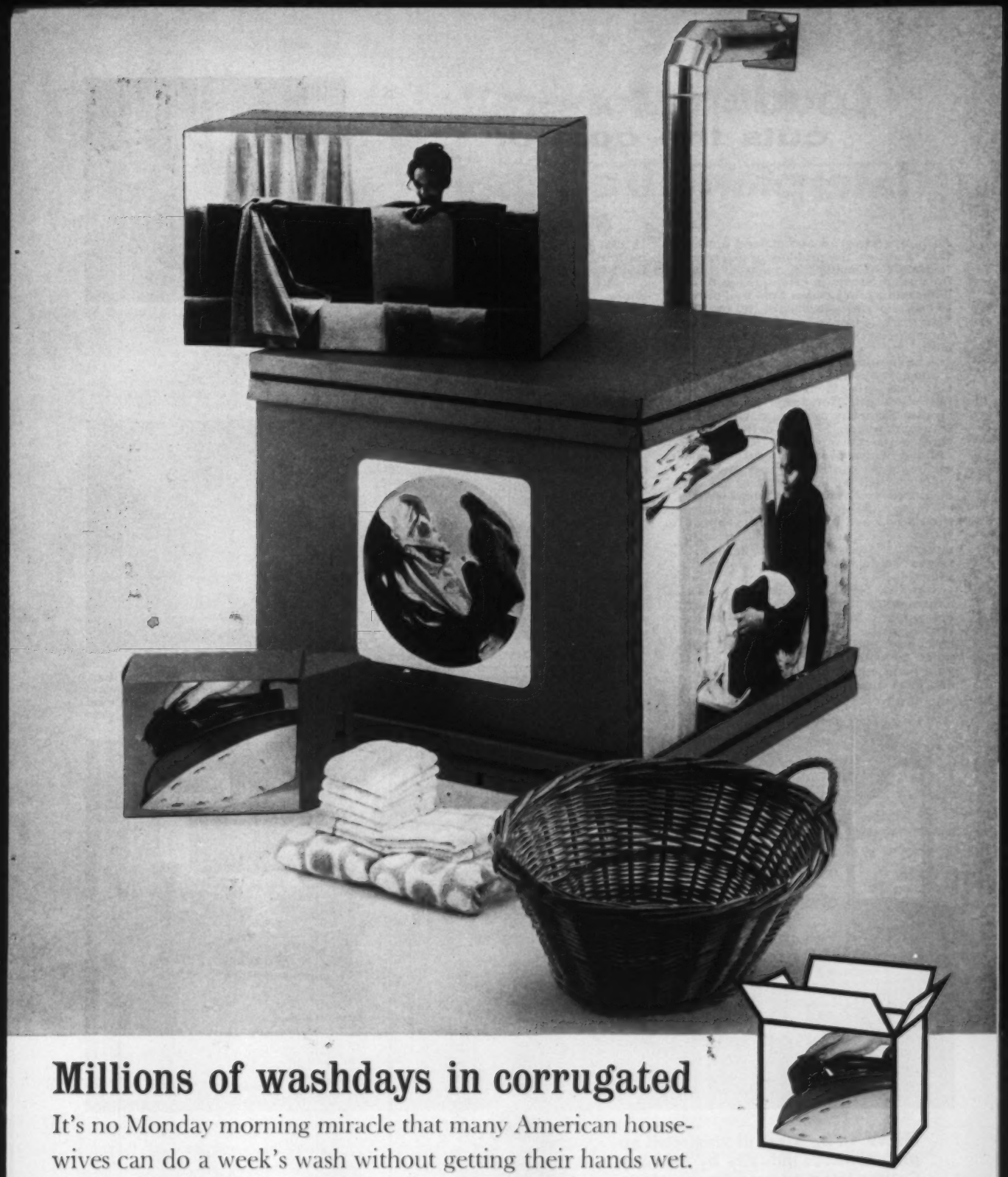
These cam systems and the air systems for carburetor jet gaging and TV tube assembly illustrate once again a fundamental truth. A basic technique for automatic manufacturing operations has broad application. Its use is not limited to a single material, a single process, or a single industry.

This identity under the skin of problems in apparently unrelated activities puts high value on cross dissemination of automation ideas and practices from one industry to another. Independent rediscovery or redevelopment of an automatic technique entails needless cost when the same knowledge could have been borrowed from another field.





Boring machine, having a cam mounted with the work-holding fixture on each spindle, simultaneously turns an elliptic form and a true cylindrical form on aluminum pistons. As indicated in the sketch, two tools are used to machine each piston. The tool to machine the elliptic skirt is mounted in a spring-loaded tool block with a cam follower.



Millions of washdays in corrugated

It's no Monday morning miracle that many American housewives can do a week's wash without getting their hands wet. And it's not surprising that thousands of automatic washers, dryers and electric irons are shipped in boxes by Hinde & Dauch Division... most dependable protection an appliance ever had. Leading appliance makers know they can look to H & D for economical *corrugated containers in volume.*

Circle 680 on Page 119

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16 Plants • 42 Sales Offices • Sandusky, Ohio

Louden Monorail
cuts the cost of
Interplant Transport

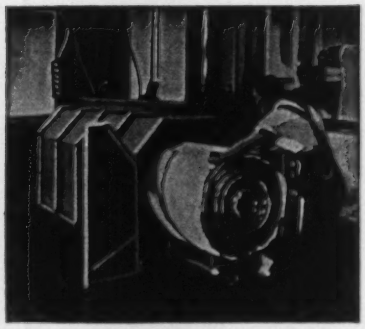
As companies grow and expand production facilities, the problem of interplant transport of materials, parts or semi-finished products is often encountered. Time and again Louden Monorail proves to be the perfect answer. With Louden's Selectomatic Control, such an interplant transport system can be virtually *automatic*.

The Louden Selectomatic Interplant Transport System at the Marion, North Carolina, plants of the Clinchfield Manufacturing Company is a good example. Here the problem developed of transporting tons of cloth daily between three separate buildings. 650 feet of Louden Monorail with a weather-proof car in almost continuous operation provides the perfect answer. The car can be raised and lowered as required for charging and discharging loads; the destination desired is preset by the control; transport is speedy, trouble-free, automatic. It is estimated three men with trucks would have difficulty doing the same job.

Louden Selectomatic Interplant Transport Systems can do many things not required in the Clinchfield installation described. It can automatically transport materials unattended from point to point anywhere in or about your plant, and it can select the shortest and most direct route to its destination. It can travel from floor to floor and building to building, open doors to let itself through and close doors behind it . . . building doors, floor doors, oven doors. It places loads in ovens or in banks of infra-red dryer lamps, turning the heat on and off as needed. It stops promptly when there is a load ahead or when it does not have the right of way, and resumes travel when the way is clear. It stops accurately at its destination and even loads and unloads its own carriers with certain classes of materials. It returns empty carriers to point of origin or places itself in storage awaiting its next call.

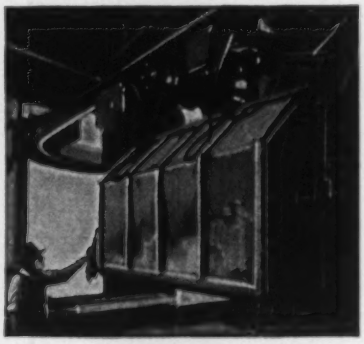
Louden Automatic Materials Handling is the guaranteed product of the pioneers and oldest company in the field of specialized monorail handling. Both the Louden field representatives and the factory engineers are highly trained specialists in the field of overhead materials handling. When you have a materials handling problem or any plant problem involving lifting and transporting loads, call on Louden for suggestions. This will cost you nothing but may prove to be the most profitable move you have ever made.

THE LOUDEN MACHINERY COMPANY
1016 Broadway, Fairfield, Iowa
A Subsidiary of Mechanical Handling Systems Inc.
Plants in Fairfield, Iowa and Clark, New Jersey

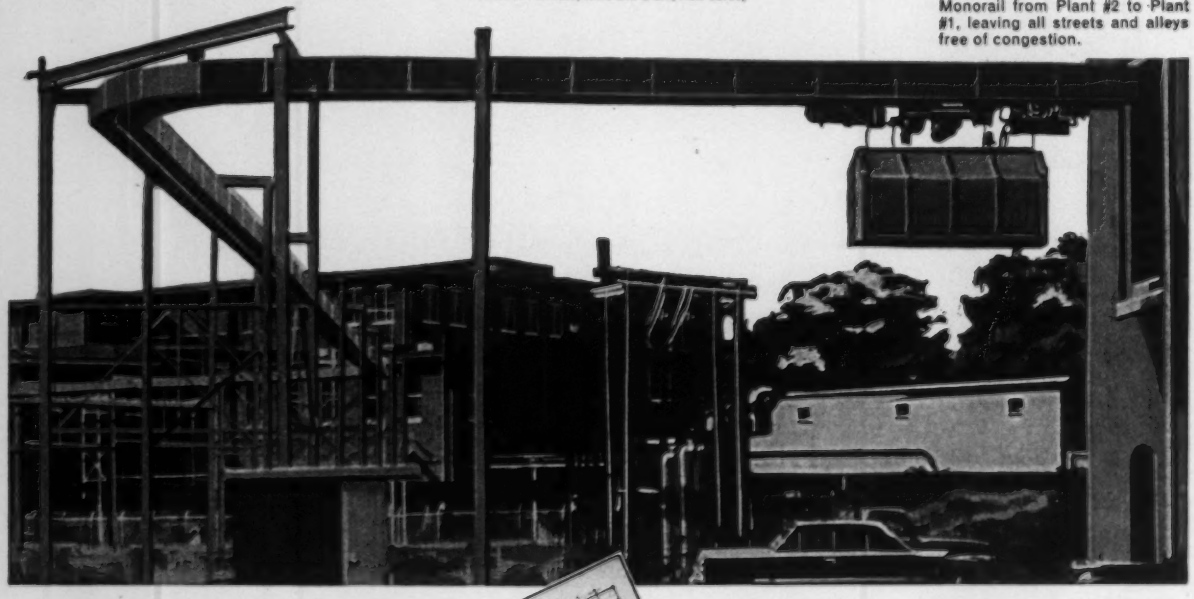


Operator loading carrier with two 650 pound beams of domestic print cloth prior to transport from loom room to cloth room.

Below:
Operator raising carrier into position, selecting destination by push button. Carrier automatically stops at desired destination.



Below:
Carrier completing trip automatically and unattended on 650 feet of Monorail from Plant #2 to Plant #1, leaving all streets and alleys free of congestion.



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MONORAIL & CRANES

Circle 681 on Page 119

Highly mechanized Rumanian factory for making vitreous china sanitary ware will use two kilns of the type shown. Unit, viewed from exit end, is 350-feet long, single deck, fired by natural gas. Kiln is fully muffled and will be operated on a 28-hour cycle. Photo supplied by Gibbons Bros. Ltd., Dudley, England.

Rumanian Ceramics Plant

HOUSING BOOM in Rumania has led to a requirement for large quantities of building materials and equipment of all sorts. Basic items in demand include sanitary ware such as lavatories and water closets.

At present, Rumania makes semi-vitreous sanitary ware and tableware in a factory that was built in Ploesti before World War I. Facilities for sanitary ware include a conventional clay preparation plant, a glaze preparation plant, and an open-flame tunnel kiln.

Recognizing the inadequacy of these facilities for its current requirements, the Rumanian government decided to build a complete new factory for sanitary ware and convert the old factory for exclusive manufacture of tableware. The new plant will be located in a suburb of Bucharest as a part of a complex also manufacturing radiators, bathtubs, and metal fittings. The group of factories in the complex will share a common maintenance shop and a boiler plant.

As a first step in planning the new sanitary ware factory, bids were invited during 1960 from Great Britain, Germany, and other European countries for a 6,000 ton per year vitreous china sanitary plant. In the same year, a team from the responsible Rumanian ministry visited these countries. After inspecting the Twyfords Alsager Works in Great Britain, the team invited a consortium of British equipment builders to visit Rumania. Subsequently, the consortium's offer for a fully mechanized sanitary ware plant was accepted and a contract signed.

Members of the British consortium include Wm. Boultons Ltd., Eric Gibbons Bros. Ltd., and Fisher & Ludlow Ltd. Under the terms of the contract, the group will supply the majority of drawings and manufacturing information for the equipment, technical assistance with the factory layout, and supervision of plant installation and initial operation. Full production is scheduled for the end of 1963.

A feature of the new plant will be its extensive use of handling equipment. For example, mechanization of the handling function will extend from the point where raw materials are unloaded from railroad cars, through processing, to the palletizing of finished products.

Quartz and feldspar will be delivered milled, while one clay will require shredding. A clay preparation plant will include clay shredders and also ball mills, blungers, filter pressers, and pump sifters.

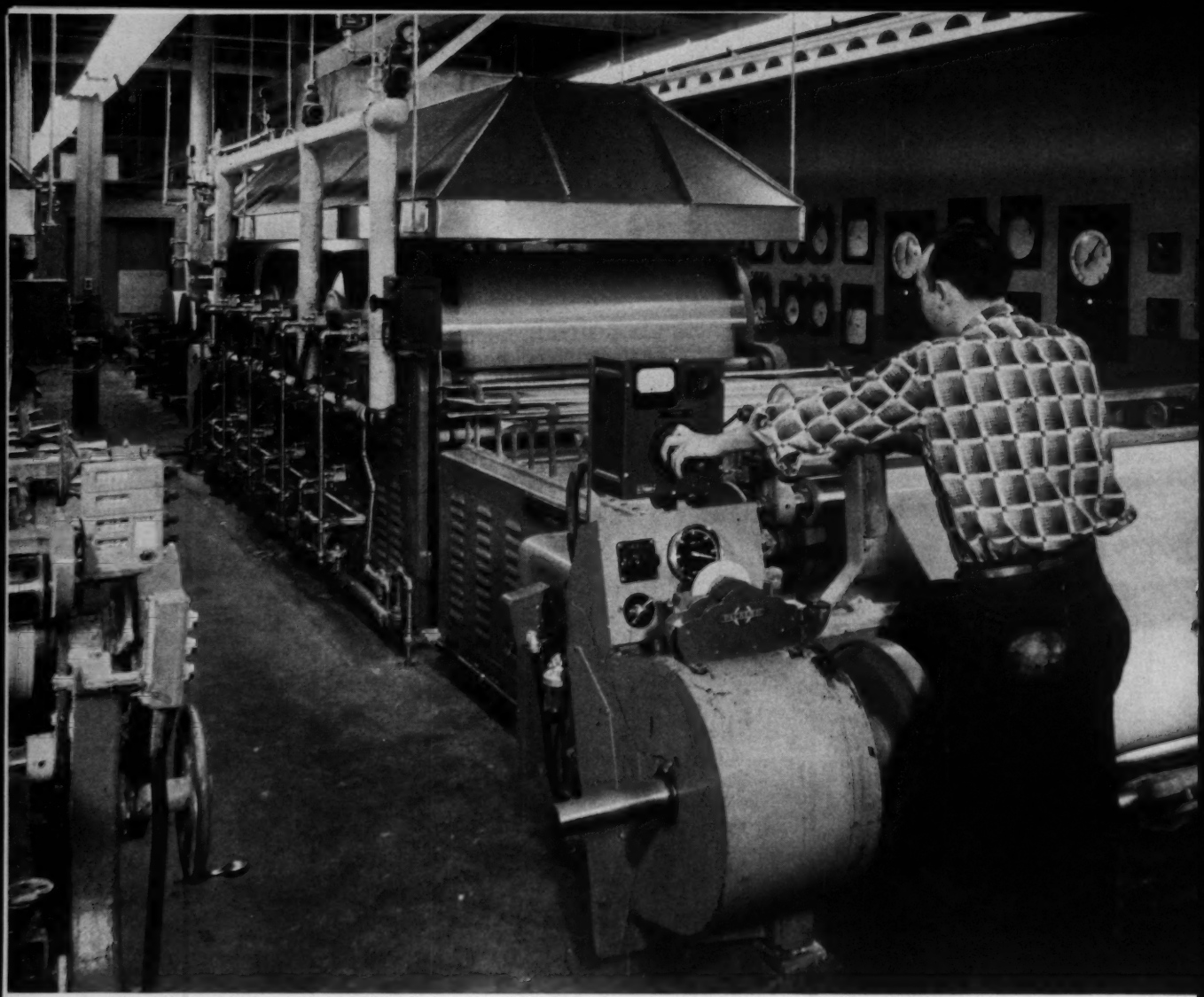
An automated casting plant to be supplied was developed from a unit built by Fisher & Ludlow in France. It includes six conveyor systems, two of which will be used for lavatories and the remainder for water closets. Each system incorporates a casting and mold drying conveyor and a primary and secondary ware drying conveyor. In addition, a mechanized casting section for small articles and a department for pressed ware will be furnished.

The glaze plant is a complete unit with initial preparation facilities. It includes four spray booths and dryers equipped to handle white and some colored glazes.

For finishing, two single deck, fully muffled kilns will be used. Fired by natural gas, the 350-foot long units will operate on a 28-hour cycle. Other facilities include a repair and re-glaze section for refires, a laboratory, and a pilot manufacturing unit including an electric kiln.

Nagoya, Japan

An order for an automatic gage control has been received by International General Electric Co. from Tokai Iron and Steel Co. for use



RELIANCE V★S SLASHER DRIVES PUT 25% MORE YARN ON THE BEAM

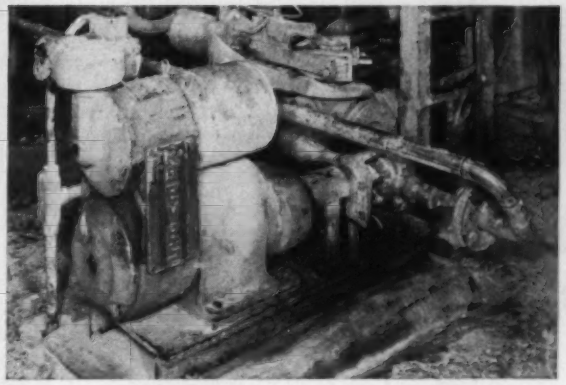
The answer is in precise tension control . . . always uniform from empty to full beam. The result: more yarn on each beam, and fewer beams to tie in. A leading textile mill finds that it can put 25% more fine count cottons on the beam with its Reliance-powered Slasher.

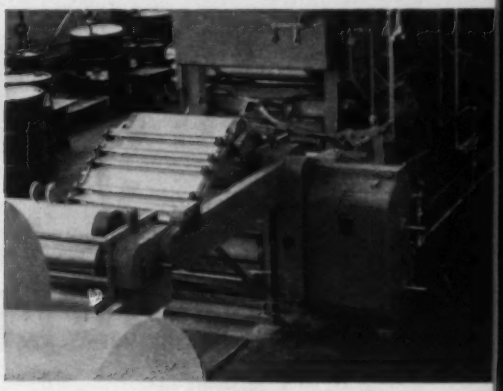
Tension precision extends to a wide range of fabrics . . . and in a wide range of speeds. Reliance V★S Drives maintain this tension during acceleration and deceleration.

Reliance Super 'T' V★S Drives now give you more horsepower in 35% less space, opening up additional usable work areas.

Let your Reliance Sales Engineer tell you about Total Service . . . the coordination of Application Engineering, Start-Up Assistance and Service—to give you complete attention from engineering to maintenance and renewal parts. Check your telephone Yellow Pages, or write or call us direct.

RELIANCE...builders of the tools of automation



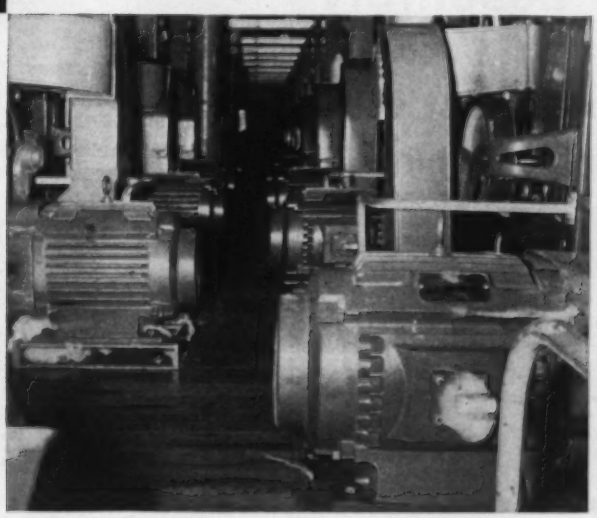


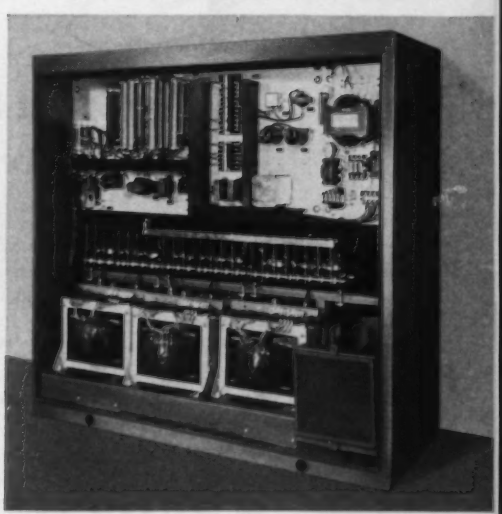
REEVES MOTODRIVE, operating this clay pump in a paper mill, demonstrates its ability to perform under rugged environmental conditions. Use of these mechanical variable speed drives is both economical and practical; they are readily adaptable to remote, manual or automatic process control (Airtrol). Horsepower ratings ¼ to 40; speed variation ranges from 2:1 to 10:1. The many thousands of space-saving assemblies (actually 49,920) mean that practically any application can be made without modification of the standard unit. Catalog G-100.

REEVES TRANSMISSIONS make possible a low-cost means of preserving constant tension on this rotogravure press. You can adjust speeds from any pick-off point of a line shaft either manually or automatically. On Reeves Transmissions, either shaft can be connected to the source of power and used as the constant speed shaft, with the other shaft driven at variable speeds. Drive connections can be any way you want them . . . belt and pulley, chain and sprocket, pinion and gear, multiple V-belt and sheaves, or direct. Bulletin T-497-3.

RELIANCE LINT-PROOF MOTOR. Completely eliminates motor cleaning and motor repairs resulting from lint accumulations. Greatly reduces all motor maintenance by providing a self-contained, completely enclosed unit which requires only infrequent lubrication. This motor is designed for conventional mountings—saves space through under-frame mounting and driving through the fan cover. Now available in 1 through 30 hp. for application on spinning, roving, drawing and twisting frames, as well as on cards, openers, pickers and other textile machines. Bulletin B-2404.

RELIANCE V★S STATATRON is a static-powered drive for wide range variable speed from in-plant a-c. circuits, available from 1 to 200 hp. Instead of a motor-generator set, the Statatron uses silicon diodes and saturable reactors to rectify the current from a-c. to d-c. These work in combination with a transistorized power exciter to supply variable voltage. Statatron is compact—smaller than conventional units. Consists of only three components: Super 'T' D-c. Motor, operator's station and control cabinet. Statatron is quiet—vibrationless, and low in maintenance cost. Bulletin D-2508.





RELIANCE ELECTRIC AND ENGINEERING CO.

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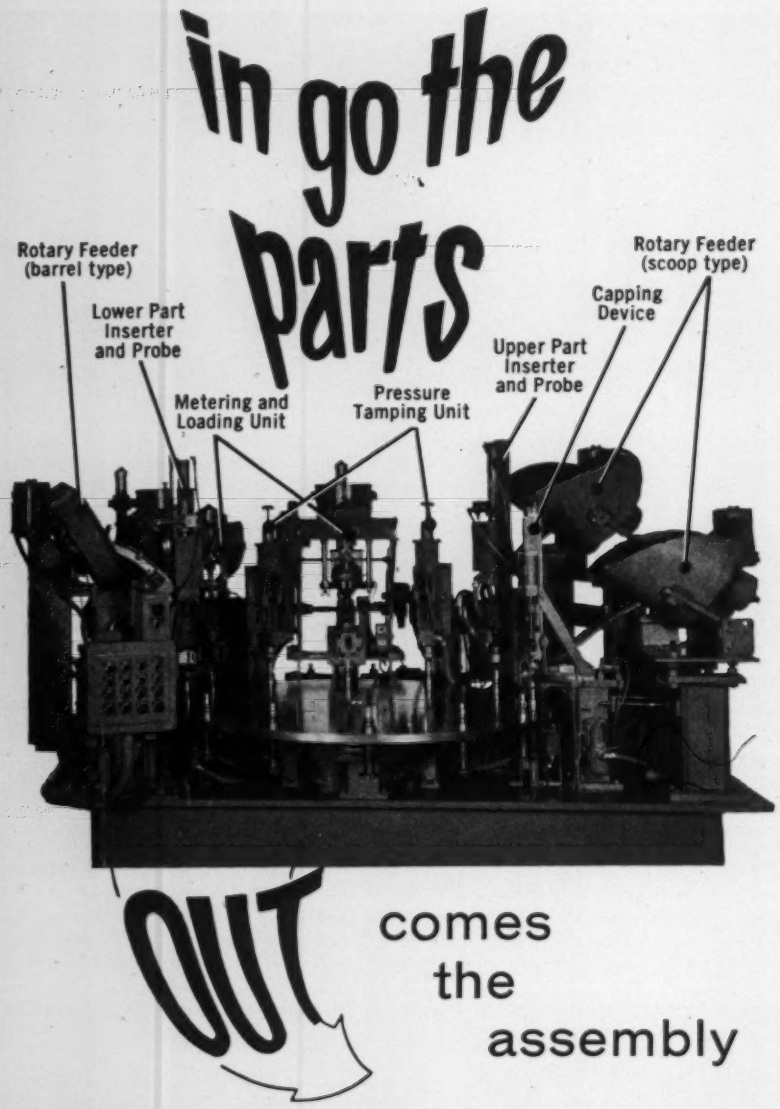


faster . . . better . . . at lower cost with a DPS special assembly machine

Micro-parts, or parts many, many, times their size . . . parts of almost any shape or material go together fast, automatically, and accurately in DPS special assembly machines. DPS experienced engineers will combine rotary feeders . . . vibratory feeders . . . elevating feeders . . . and power screwdriving machines with other processing equipment to feed, orient and assemble parts. If you have an assembly problem, let a DPS engineer analyze your production line. DPS special assembly and processing machines can give you higher-speed production . . . better quality control . . . and substantial reduction in assembly costs. Write today.

15,728

DETROIT POWER SCREWDRIVER CO.

A Subsidiary of Link-Belt Company

Selective Parts Feeders; Screw, Nut and Stud Driving Machines; Special Purpose Assembly Machines

2811 W. Fort Street Detroit 16, Michigan TAshmoo 5-3070

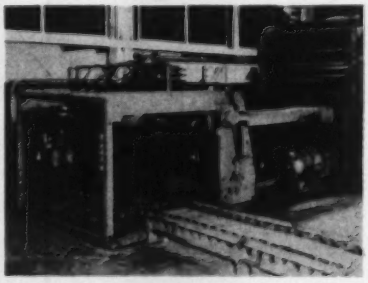
on a new, 68-inch continuous hot strip finishing mill. The system will control thickness of sheet steel produced in the mill, and will have an electrohydraulic-operated vernier screw control for fast response in compensating for thickness deviation. Other equipment includes an x-ray gage to monitor a range of strip gages between 1 and 9.35 mm, and a photoelectric type gage to check widths up to 62 inches. Prime contractor for the mill is United Engineering and Foundry Inc.

Poona, India

Major world markets may soon feel the impact of competitively priced semiconductors carrying the label, "Made in India." A facility now under construction by Semiconductors Private Ltd. is expected to produce transistors and diodes by the end of the year. The government-licensed firm is owned jointly by Raytheon Co. and two Indian businessmen, I. T. Mirchandani and T. J. Lalvani. Raytheon's Semiconductor Div. will supply capital equipment, engineering information, and manufacturing training for the new plant.

Moscow, Russia

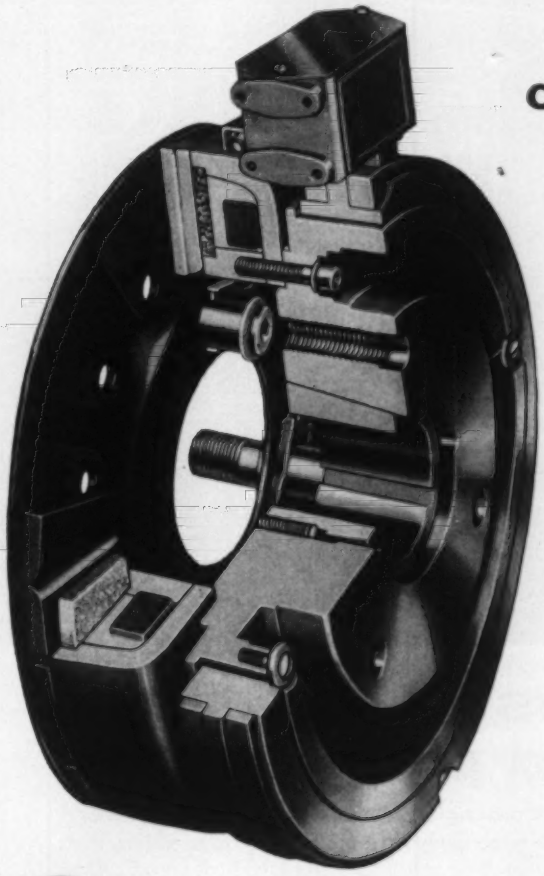
Undergoing tests at an automobile plant is a magnetic pump for transportation of liquid cast iron, according to a U. S. Dept. of Commerce translation from the Russian publication Izvestiya. The pump uses a traveling magnetic field to transfer molten metal directly from a melting furnace into molds. Method eliminates the need for conventional ladles and cranes.



Sheet feeder of type shown has been built by Dexter Co. for use in a Spanish drum making facility. Unit will feed steel sheets in stacks weighing up to 30,000 lb to a lithograph press for decorating prior to forming into drums.

Circle 683 on Page 119

EATON
DYNA-TORQ®
MAGNETIC-FRICTION CLUTCHES and BRAKES



The Ideal Solution to Exacting Clutching and Braking Problems

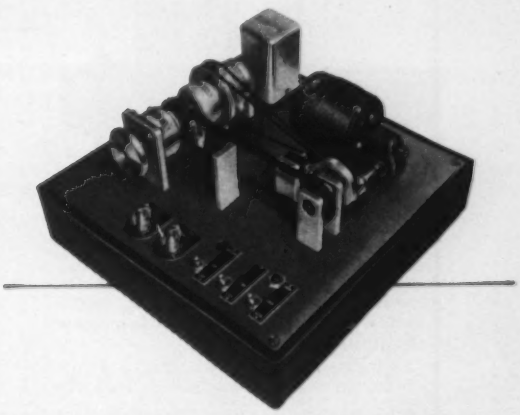
These highly responsive, trouble-free units provide accurate control of intricate automatic machinery. Operating on 6, 12, 24 or 90 V.D.C., Dyna-torQ units may be actuated by micro-switches, photo-electric cells, relays or any "ON-OFF" signal to perform a wide range of functions in processing and fabricating applications. The compact rectifier type control converts AC power to DC power and may be remotely mounted out of busy machine areas.

Eaton Dyna-torQ Clutches and Brakes are available from 1¾" through 15" in diameter. They may be easily and quickly installed on either new or existing plant equipment. Exclusive features of design and construction mean worthwhile savings.

HP @ 1800 R.P.M. *(Typical Application)*

MODEL	HP	MODEL	HP
302	1/20	308	7½
303	½	310	10
304	1	312	20
305	2	315	25

Dyna-torQ Distributors in many principal cities carry Dyna-torQ Clutches and Brakes in stock for immediate delivery.



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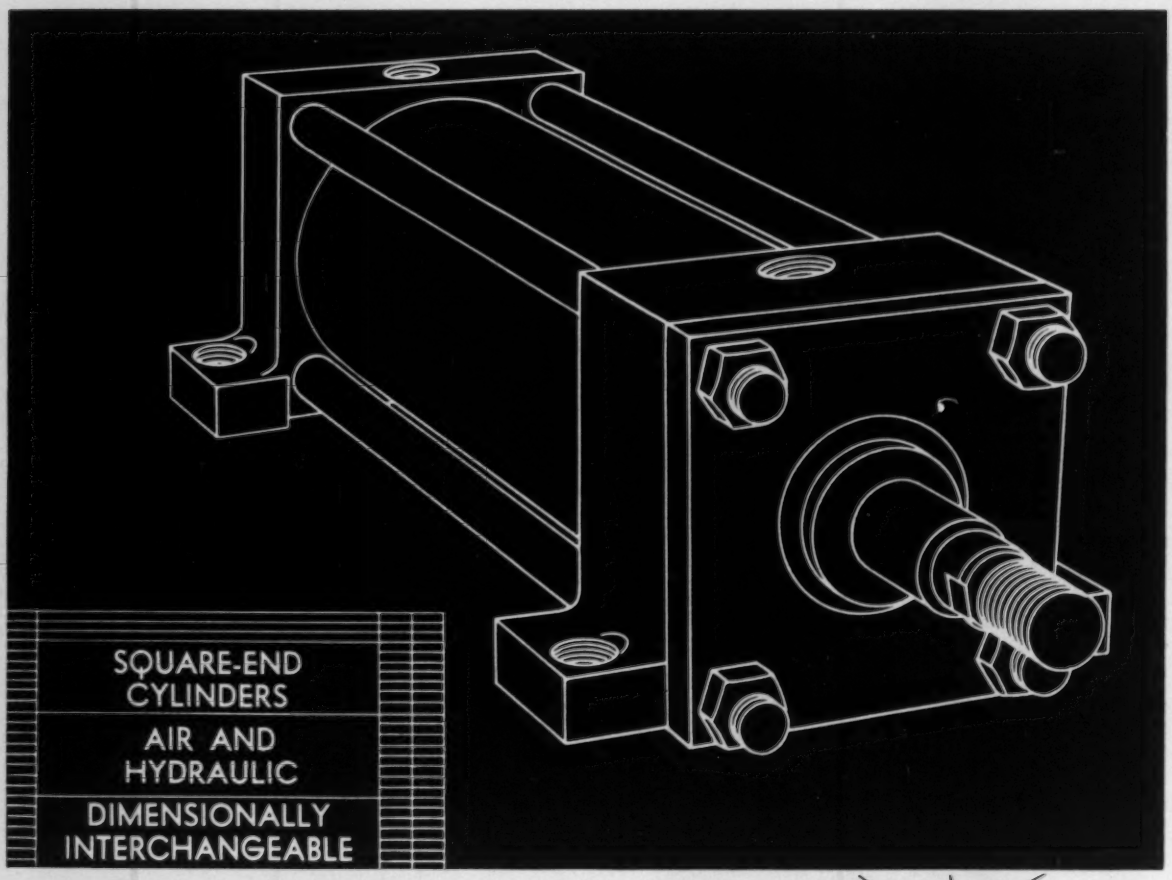
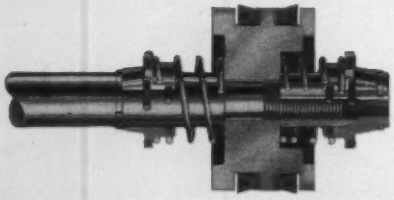
Circle 684 on Page 119



How MEAD takes the BUMP out of high-speed pistons



FULL FLOATING CUSHIONS

Detail shows two-stage feature of full floating cushion on a piston used for hydraulic pressures over 250 psi. MEAD Square-End Cylinders also offer these other design advantages:

- Seamless, hard drawn, micro-finish brass barrel for long piston seal life
- Cold drawn steel cylinder heads with all surfaces permeated with black oxide for rust resistance
- High tensile chrome plated steel piston rods
- Accurately machined rod bearing cartridge made of solid bearing bronze

Special *full floating cushions* in new MEAD Square-End Cylinders are uniquely mounted on springs rather than on solid studs. The result is a smooth, high-speed piston advance without the use of ball checks. In hydraulic units, the two-stage design of the floating cushions completely eliminates bumping. Fully adjustable from the slightest measurable cushioning effect to complete stoppage, the full floating feature also reduces cushion wear caused by impurities in the working medium. In air models up to 250 PSI and hydraulic units up to 1000 PSI, MEAD Square-End Cylinders are available in a full range of bore, stroke and piston sizes. Complete selection of mounting styles. All units are dimensionally interchangeable and conform to JIC specifications. For consultation and information on quick delivery and competitive prices, write to MEAD *today*.

PRODUCTS FOR AUTOMATION

MEAD

FLUID DYNAMICS

A DIVISION OF MEAD SPECIALTIES CO.
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ASK YOUR MEAD MAN about 24-hour service on most MEAD products . . . 48 hours on special orders.

Circle 685 on Page 119

OCTOBER 1961

Debugging

Concise understanding of terms of transactions is vital to harmonious dealings in automated production equipment. Hard feelings and negative reactions can close doors to future sales if the user company doesn't clearly understand what it is getting when, for how much money. Trouble can also occur if the equipment builder doesn't recognize what is expected of him.

This problem was picturesquely described in a letter from a Japanese firm: "A word of 'Debugging' is practically new to us whereby many discrepancies and difficulties are experienced by us since when automatic machine was imported here. Inasmuch as keen need is found for perfect understanding of this word so to close this contract satisfactorily, we would thank you very much to furnish us requested information by return."

Ingenious as the designer may be, there is always something on the "one-of-a-kind" production machine that requires some "after-the-fact" adjustment or revision. How serious these changes may be depends considerably upon the co-operative attitude of those who must operate the new equipment and whether or not they have a real desire to make things click.

One equipment builder classifies debugging crews into two attitude groups: 1. Let's scrap this method and start from scratch. 2. Let's persevere—we've almost got it. Each is sometimes successful. Management must recognize the inevitability of debugging, be ready to pay the cost, be able to identify personnel attitudes toward it, and choose the right one for a particular assignment. This is not always easy.

Good advice as to where to start was found on a circuit diagram blueprint issued by a machine tool builder: "NOTE: CONSIDERING THE INVESTMENT YOU HAVE MADE PLEASE TRY OUR WAY FIRST."

James C. Keebler

EDITOR

AUTOMATION

A LOOK AT INVESTMENT AND PAYBACK

To be compared realistically, different capital investment proposals must be evaluated in the same frame of reference. The author outlines a system for economic justification calculations on a uniform basis throughout a multiplant corporation.

By **SAMUEL B. KORIN,** Manager, Manufacturing Equipment Development, International Business Machines Corp., New York, N. Y.

TODAY, capital investments are under greater scrutiny, control, and analysis than ever before, and for good reason. Cost competition, the impact of foreign markets, rising labor costs, and rising equipment prices make the efficient commitment and use of capital funds mandatory. Over and above cost factors, rapidly expanding technology has made the realization of a reasonable profit from capital investment a race against time.

The problem of capital investment has further been complicated by the trend toward special purpose production equipment brought about by the advent of automation, electronics, numerical control, and unique manufacturing processes. This trend has resulted in a rash of techniques and concepts for economic justification of capital equipment ranging from simple approaches to complex mathematical formulas.

Most economic justification techniques described in recent literature simply show how to summarize to arrive at a rate of return and payback. Some even imply claims of universal application for all investment situations. But very few deal comprehensively with the development of the basic cost data which is the very essence of the investment analysis.

Proper preparation of cost data should be treated with as much care in economic justification as preparing a statement of income and expenses for income tax purposes. Though one's calculations be accurate, errors of omission or departure from rules can result in trouble whether justifying equipment or justifying tax calculations.

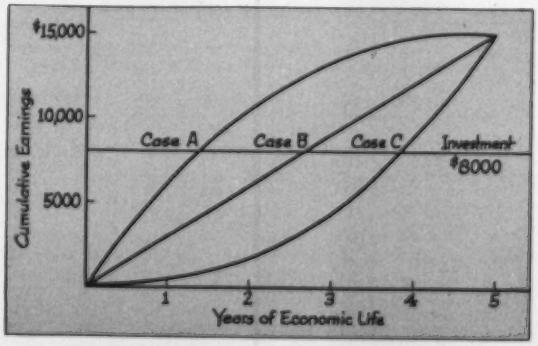
The requirement for careful cost data preparation is the basis for a new economic justification procedure and forms recently developed in International Business Machines Corp. It was recognized by IBM's Manufacturing Process Council that, in a large multiplant corporation, the many manufacturing analysts who prepare economic justification forms have different interpretations of the several cost items and may be guided by different ground rules in generat-

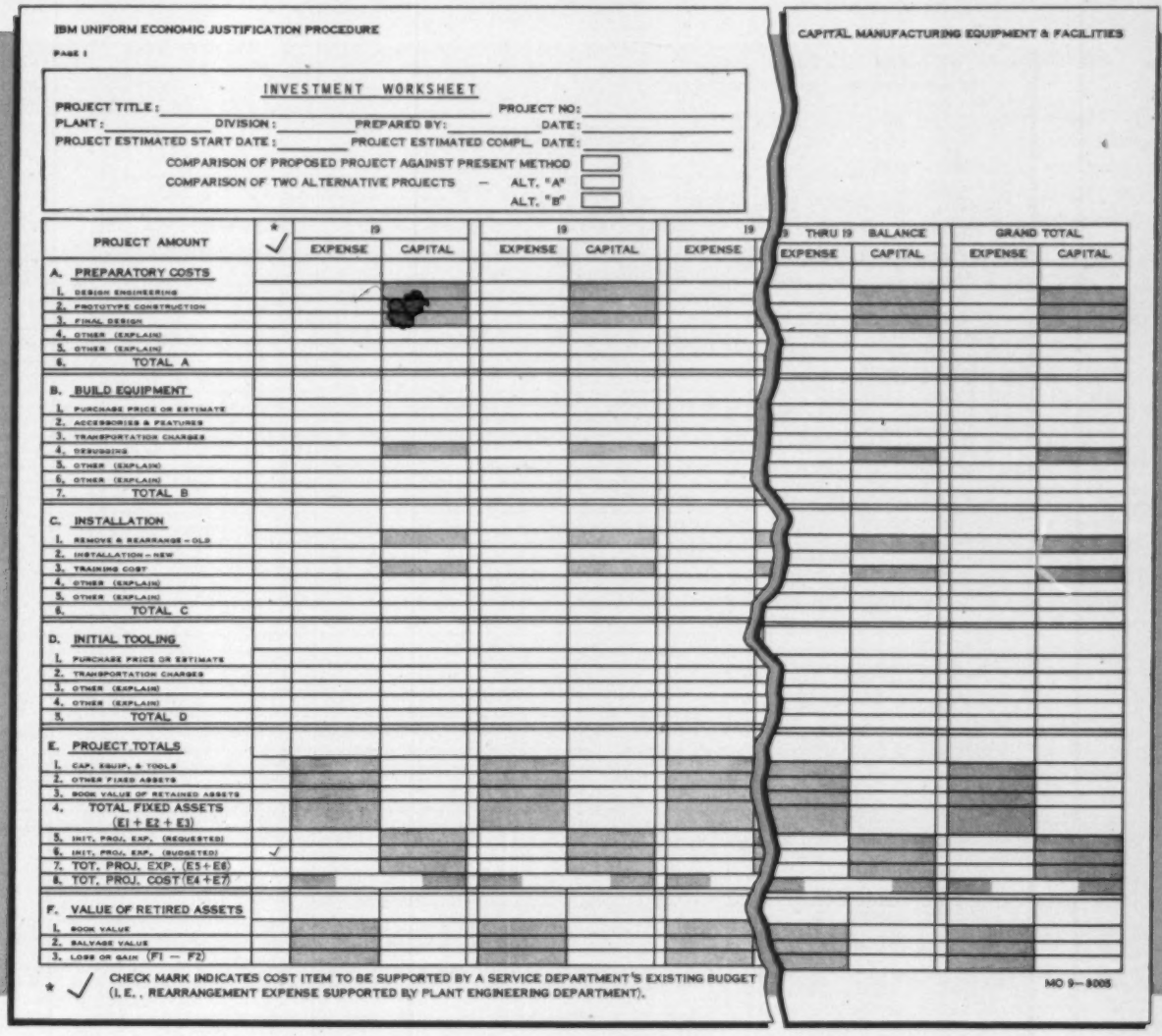
This article is based on a paper presented at the "Fifth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and the Manufacturing Engineering Council, April 1961.

Investment: $8000

Economic Life (years)	CASE A	CASE B	CASE C
1	$5000	$3000	$ 500
2	6000	3000	1000
3	2000	3000	2500
4	1000	3000	6000
5	1000	3000	5000
Total Earnings:	$15,000	$15,000	$15,000
Payback:	1.4 years	2.7 years	3.8 years

Fig. 1—Plots of payback curves for three different schedules indicate the impact of different production schedules on actual payoff. Although the three cases shown have the same average rate of earning over the total economic lives of the equipment involved, the true times for payoff vary significantly.





IBM UNIFORM ECONOMIC JUSTIFICATION PROCEDURE

PAGE 1

CAPITAL MANUFACTURING EQUIPMENT & FACILITIES

INVESTMENT WORKSHEET

PROJECT TITLE: _____ PROJECT NO: _____

PLANT: _____ DIVISION: _____ PREPARED BY: _____ DATE: _____

PROJECT ESTIMATED START DATE: _____ PROJECT ESTIMATED COMPL. DATE: _____

COMPARISON OF PROPOSED PROJECT AGAINST PRESENT METHOD ☐

COMPARISON OF TWO ALTERNATIVE PROJECTS — ALT. "A" ☐ ALT. "B" ☐

PROJECT AMOUNT	* ✓	19 EXPENSE	19 CAPITAL	19 EXPENSE	19 CAPITAL	19 EXPENSE	19 THRU 19 BALANCE EXPENSE	19 THRU 19 BALANCE CAPITAL	GRAND TOTAL EXPENSE	GRAND TOTAL CAPITAL
A. PREPARATORY COSTS										
1. DESIGN ENGINEERING										
2. PROTOTYPE CONSTRUCTION										
3. FINAL DESIGN										
4. OTHER (EXPLAIN)										
5. OTHER (EXPLAIN)										
6. TOTAL A										
B. BUILD EQUIPMENT										
1. PURCHASE PRICE OR ESTIMATE										
2. ACCESSORIES & FEATURES										
3. TRANSPORTATION CHARGES										
4. DESUDDING										
5. OTHER (EXPLAIN)										
6. OTHER (EXPLAIN)										
7. TOTAL B										
C. INSTALLATION										
1. REMOVE & REARRANGE – OLD										
2. INSTALLATION – NEW										
3. TRAINING COST										
4. OTHER (EXPLAIN)										
5. OTHER (EXPLAIN)										
6. TOTAL C										
D. INITIAL TOOLING										
1. PURCHASE PRICE OR ESTIMATE										
2. TRANSPORTATION CHARGES										
3. OTHER (EXPLAIN)										
4. OTHER (EXPLAIN)										
5. TOTAL D										
E. PROJECT TOTALS										
1. CAP. EQUIP. & TOOLS										
2. OTHER FIXED ASSETS										
3. BOOK VALUE OF RETAINED ASSETS										
4. TOTAL FIXED ASSETS (E1 + E2 + E3)										
5. INIT. PROJ. EXP. (REQUESTED)										
6. INIT. PROJ. EXP. (SUGGESTED)	✓									
7. TOT. PROJ. EXP. (E5 + E6)										
8. TOT. PROJ. COST (E4 + E7)										
F. VALUE OF RETIRED ASSETS										
1. BOOK VALUE										
2. SALVAGE VALUE										
3. LOSS OR GAIN (F1 — F2)										

* ✓ CHECK MARK INDICATES COST ITEM TO BE SUPPORTED BY A SERVICE DEPARTMENT'S EXISTING BUDGET (I.E., REARRANGEMENT EXPENSE SUPPORTED BY PLANT ENGINEERING DEPARTMENT).

MO 9—8005

Fig. 2—Investment Worksheet Form is one of two basic forms developed for company-wide use in IBM as part of a Uniform Economic Justification Procedure for manufacturing equipment and facilities.

ing data. This Manufacturing Process Council, incidentally, is a group consisting of management representatives from each plant's Manufacturing Engineering Department, as well as a representative of the Corporate Manufacturing Services Staff. Its purpose is to explore new manufacturing concepts of common interest to all plants, to interchange technical information, and propose corporate manufacturing standards.

At one of its quarterly meetings, the Council set up a Subcommittee for Economic Justification and charged it with the responsibility of designing and proposing a uniform procedure and forms to substantiate appropriation requests for new production equipment. The resulting effort of this task force represents a consolidation of all that has been experienced in IBM's separate plants, with representatives from all plants collaborating with Corporate Manufacturing Services to develop a procedure compatible with the individual needs of plants. Because all plants are a party to it, full acceptance and co-operation are assured.

▶ Uniform Economic Justification Procedure

The procedure developed includes an Investment Worksheet form and a Computations Worksheet form, with descriptions and rules governing their use. The purpose of the procedure is to:

1. Provide a uniform treatment, as well as definition of all basic cost information related to the projects under consideration.

2. Provide a check list of cost and investment factors.

3. Serve as a time plan for scheduling and developing cost data for each year of a project's life.

4. Provide a standardized method of summarizing cost data in order to evaluate investment proposals.

5. Provide the basis for a post-audit review.

IBM UNIFORM ECONOMIC JUSTIFICATION PROCEDURE

PAGE 1

COMPUTATIONS WORKSHEET

PROJECT TITLE: _____ PROJECT NO.: _____

PREPARED BY: _____ DATE: _____

USEFUL LIFE OF PROJECT (ECONOMIC LIFE) _____ YRS.

PURPOSE: 1. EXPANSION ☐ 2. PRODUCT IMPROVEMENT ☐ 3. COST REDUCTION ☐ 4. OTHER SPECIFY ☐

FINANCIAL COMPUTATIONS	19 PRESENT "A"	19 PROPOSED "B"	19 PRESENT "A"	19 PROPOSED "B"	19 PRESENT "A"	19 PROPOSED "B"	19 PRESENT "A"	19 PROPOSED "B"	19 PRESENT "A"	19 PROPOSED "B"
G. ANN. OPERATING COSTS										
1. DIRECT LABOR										
2. SETUP LABOR										
3. MFG. ENG. SUPPORT										
4. MAINTENANCE LABOR										
5. OTHER INDIRECT LABOR										
6. EMPL. BENEF. (20% G1 THRU G5)										
7. DIRECT MATERIAL										
8. SPOILAGE & SCRAP (INC. REW.)										
9. INVENTORY CARRYING COST										
10. FLOOR SPACE										
11. UTILITIES (POWER, ETC.)										
12. MAINTENANCE PURCHASED										
13. REBUILD/OVERHAUL										
14. EXPENSE TOOLS										
15. OPERATING SUPPLIES										
16. PROP. TAXES & INSURANCE										
17. DEPRECIATION – STRAIGHT LINE										
18. DEPRECIATION – SUM YRS. DIGITS										
19. WRITE OFF – PRES. ASSETS RET.										
20. INITIAL EXPENSES (E7)										
21. OTHER										
22. OTHER										
23. TOTAL G										

H. ANN. SAV. & REPAY. OF INVEST.	"C"	"C"	"C"	"C"	"C"
1. SAV. BEFORE TAXES (G23A – G23B)					
2. NET SAV. AFTER TAXES (48% OF H1)					
3. WRITE OFF DIFF. (G19B – G19A)					
4. ADJ. NET INCOME (H2 + H3)					
5. DEP. DIFF. (G17B + G18B) MINUS (G17A + G18A)					
6. ANN. REPAYMENT (H4 + H5)					
7. REPAY. TO DATE (CUM. TOT. H6)					

J. INVESTMENT REQUIRED	PRESENT "A"	PROPOSED "B"	C = B – A
1. AVERAGE INVENTORIES			
2. TOTAL FIXED ASSETS (E4)			
3. SAL. VAL. ASSETS RET. (F2)			
4. TOTAL FIXED INVEST. (J2 – J3)			
5. TOTAL (ECO. LIFE) DEPREC. – STRGT. LINE (G17 FOR COL. A & B)			
6. TOTAL (ECO. LIFE) DEPREC. – SUM YRS. DIGITS (G18 FOR COL. A & B)			

J. INVESTMENT REQUIRED (CONT.)	PRESENT "A"	PROPOSED "B"	C = B – A
7. AVERAGE TOT. DEPREC. (50% OF J5 + 65% OF J6)			
8. AVER. INVEST. (J1 + J4 – J7)			
9. AVER. ADJ. NET INCOME (TOT. H4 ÷ ECON. LIFE)			
10. RET. ON AVER. INVEST. (J9 ÷ J8)			
11. PAYBACK (COMPARE J4 WITH H7)	___ YRS ___ MOS	___ YRS ___ MOS	

Since the summarized results (rate of return and payback) are based on clearly defined instructions for each cost item, it is possible to compare appropriation requests from two or more plants attempting to justify different approaches to the same project requirement. It is also possible to rank the profitability of a variety of appropriation requests with greater assurance of accuracy due to the uniformity with which the basic data were developed.

Forms outlining the economic justification constitute a comprehensive check list, and though every item may not be applicable in every case, a significant item cannot be overlooked. Although the Procedure Manual is a book of 27 pages, it is recognized and accepted as a check list reference.

The production forecast is the timing belt to which all cost data must be geared. It determines the date on which the proposed equipment is to be operational as well as its economic life span. But most important, the production forecast indicates the annual machine utilization rate. For the sake of simplicity, many companies will estimate cost savings on a per-year basis, averaging out fluctuations in the production schedule over the economic life of the project. Where the production schedule curve varies significantly, this practice of averaging can result in an erroneous payback by indicating an earlier or later return than the actual case. Forms used in our procedure provide six columns to reflect the impact of varying production schedules on cost and savings during each year of the equipment's economic life.

Plotting of curves based on such data, *Fig.* 1, gives a realistic picture because it is based on a production schedule rather than on the proposed machine's capacity: It shows the true point in time where payoff actually occurs. Two important points of information are available from a realistic curve such as this. First, if peak production is to be reached only after a certain time, there is a period of uneconomic machine utilization which can be taken into consideration as a cost factor. Second, in the case of a crash program, if the early peak production is not met, the curve may show that remaining production is not sufficient to amortize the machine.

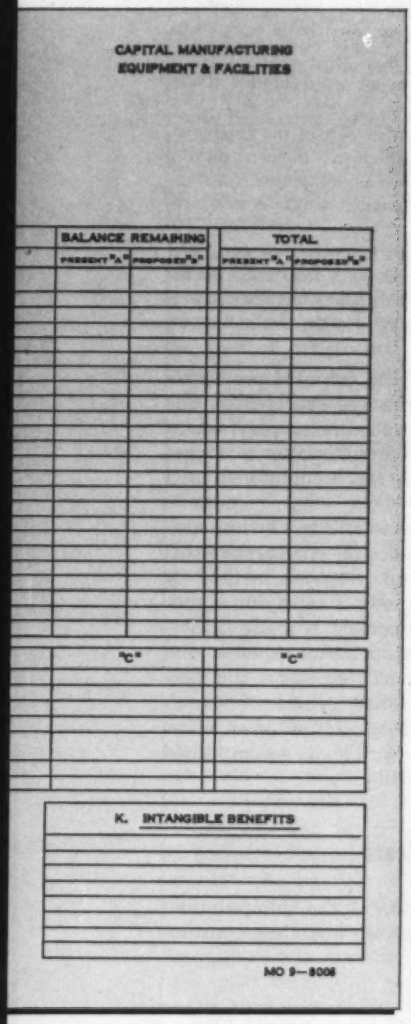


Fig. 3—Computations Worksheet form is used with Investment Worksheet form to uniformly assess proposed manufacturing projects. Alternate methods can be compared and rates of return and paybacks calculated.

Payback and rate of return on average investment are the standard measures of financial profitability used. The rate of return on average investment is simply a means of measuring the profitability of a project relative to the funds invested in it. It provides a means of determining whether the project meets minimum standards of profitability, and it also makes it possible to rank or compare a variety of projects competing for capital funds, according to their profitability. Payback, on the other hand, measures the liquidity of funds invested in a project. When compared with the economic life of the project, payback indicates the degree of risk associated with it. Payback should, of course, always be less than economic life; the shorter the time gap between payback and economic life, the higher the rate of return should be to justify the risk.

Because the forms and procedures have been designed to be compatible with accounting practices, a post audit of the project is possible to cover the investment costs as well as the annual operating expenses.

▶ Ground Rules for Uniform Justification

The Procedure Manual is the written instrument for assuring standard use of the standard forms and is specifically designed for manufacturing engineers to understand by avoiding accounting terminology as far as possible. Six ground rules are provided which help clarify and define the factors to be considered and avoid the possibility of different people arriving at different interpretations.

1. Feasibility Studies. Technical feasibility is defined as an evaluation of untried or unproved technical design concepts undertaken to minimize risks on further investments in new manufacturing equipment. The cost of proving feasibility should be kept to a minimum and should be limited to that considered necessary to minimize risks. Time and costs expended for technical feasibility and economic feasibility studies should not be included in the project cost of a proposal but should rather be absorbed by the normal Manufacturing Engineering budget (i.e., Manufacturing Research, Advanced Manufacturing Development, Methods Engineering, etc.).

2. Economic Life Period. This is the number of scheduled months that the product is to be manufactured. The economic life of a project starts when the new manufacturing equipment is scheduled for release to production. Economic life terminates when the manufacturing requirements for the new equipment phase out (i.e., the last year of the most reliable production schedule available) or when the equipment is expected to wear out—whichever comes first. Annual operating costs and payback calculations should coincide with the time period of the economic life. Other factors which may influence the economic life period are:

Stability of product design—The number of months that the product, or its component, to be produced by the proposed equipment, will remain stable without any major design changes which might technologically obsolete the new equipment.

Contract life—The number of scheduled months remaining in a given military contract.

Reliability of the production schedule or forecast.

Service life of the tools—The number of months of useful productive life that can be expected from the proposed equipment operating on a one-shift basis.

3. Basic Manual Method. Comparison of a proposed equipment project against a manual method should be based on the best manual method which incorporates low-cost, labor saving devices. Where a present manual method is being compared, the actual hours experienced should not be used unless they represent the optimum method as determined by the local methods engineering department. The purpose of having actual hours verified in this manner, is to make certain that investment projects are not justified against grossly inefficient present methods.

4. Contingency Factors. Although contingency

factors are permissible as a cushion for estimating errors, and as a hedge against risks, contingencies can and should be minimized through information provided by technical feasibility studies.

5. Minimum Project Cost Level For Use of Economic Justification Forms. The Uniform Economic Justification Forms are recommended at IBM for application to equipment projects starting at $5000. The use of these forms for equipment projects starting at $25,000 is highly desirable where the investment decision involves any degree of risk. The forms should be prepared prior to initiating an appropriation request and used for the purpose of substantiating such a request.

6. Identifying Actual Cost for Post Audit Purposes. Accounting procedure should be established which makes it possible to identify and accumulate the following major categories of expenditure for each approved appropriation—Preparatory Costs; Build Equipment; Debugging; Installation; Initial Tooling.

All design and capital costs incurred which are directly related to the appropriation should be charged to one of the above categories by means of job or shop numbers.

Use of the Worksheets

The Investment Worksheet, *Fig.* 2, provides an itemized listing of all initial cost factors related to the proposed project which will be incurred before the new manufacturing equipment is released to production. This work sheet has five principal functions:

1. Serves as a guide or check list for all investment cost factors.

2. Serves as a time plan for scheduling various phases of the proposed equipment—Preparatory costs; Build equipment; Installation; Initial tooling.

3. Identifies each cost item as capital or expense for appropriate tax treatment.

4. Identifies each cost item as either part of the appropriation request or as previously authorized through existing budgets. This assures consideration of all project costs involved over and above the appropriation which is being requested.

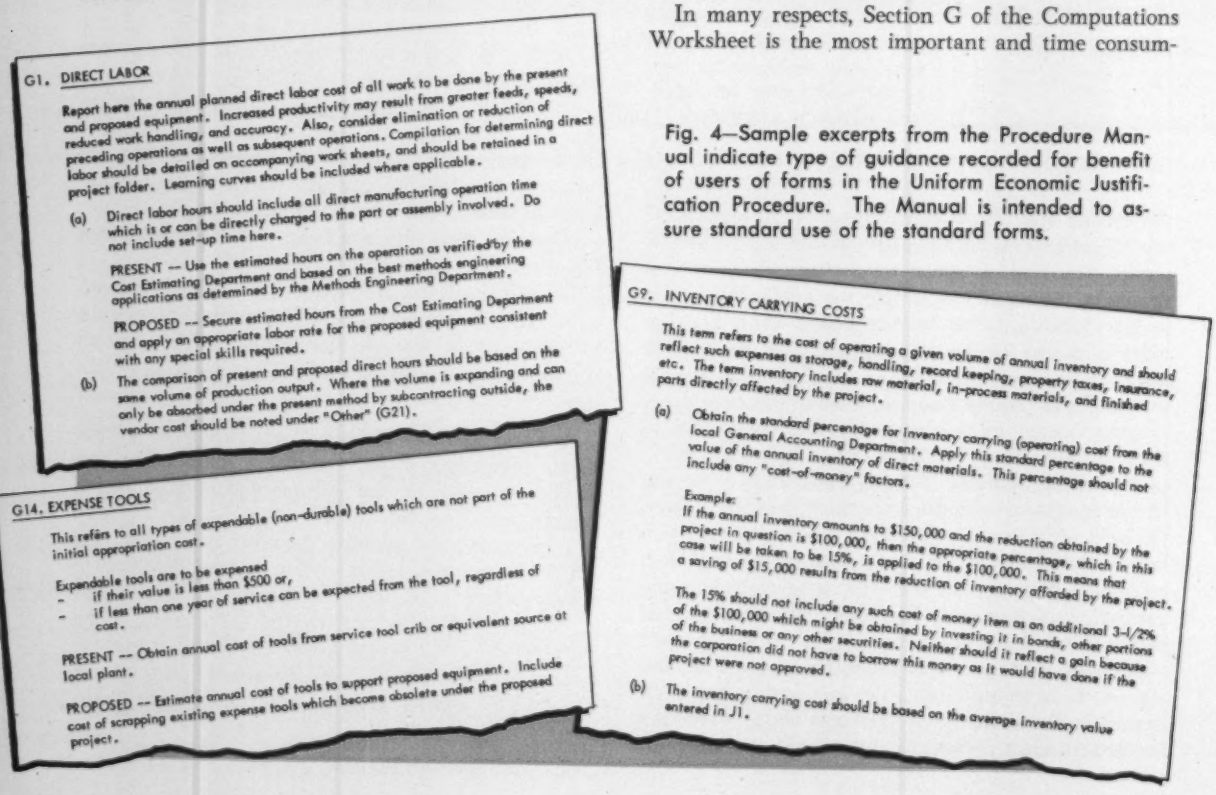
5. Provides the basis for a post-audit review of the actual initial project costs incurred as well as a time check of the project's progress. This is particularly important since considerable savings may be lost by not having the equipment operational on time.

To reflect the planning of the proposed project on a time schedule basis, columns are provided for the first four years in which expenditures may occur. Where a proposed project extends over a longer period, planned expenditures are accumulated in a "Balance" column.

The Computations Worksheet, *Fig.* 3, has two basic functions: First, it provides for comparative cost analysis between a present or proposed method or between two alternative methods of satisfying a production schedule. This comparison is made in Section G of the form for each operating expense item during each year of the project's economic life. Second, the Computations Worksheet provides for analysis of the gross savings and calculation of an after-tax rate of return and payback. This is accomplished in Sections H and J of the form.

Annual Operating Costs

In many respects, Section G of the Computations Worksheet is the most important and time consum-



G1. DIRECT LABOR

Report here the annual planned direct labor cost of all work to be done by the present and proposed equipment. Increased productivity may result from greater feeds, speeds, reduced work handling, and accuracy. Also, consider elimination or reduction of preceding operations as well as subsequent operations. Compilation for determining direct labor should be detailed on accompanying work sheets, and should be retained in a project folder. Learning curves should be included where applicable.

(a) Direct labor hours should include all direct manufacturing operation time which is or can be directly charged to the part or assembly involved. Do not include set-up time here.

PRESENT -- Use the estimated hours on the operation as verified by the Cost Estimating Department and based on the best methods engineering applications as determined by the Methods Engineering Department.

PROPOSED -- Secure estimated hours from the Cost Estimating Department and apply an appropriate labor rate for the proposed equipment consistent with any special skills required.

(b) The comparison of present and proposed direct hours should be based on the same volume of production output. Where the volume is expanding and can only be absorbed under the present method by subcontracting outside, the vendor cost should be noted under "Other" (G21).

G14. EXPENSE TOOLS

This refers to all types of expendable (non-durable) tools which are not part of the initial appropriation cost.

Expendable tools are to be expensed
- if their value is less than $500 or,
- if less than one year of service can be expected from the tool, regardless of cost.

PRESENT -- Obtain annual cost of tools from service tool crib or equivalent source at local plant.

PROPOSED -- Estimate annual cost of tools to support proposed equipment. Include cost of scrapping existing expense tools which become obsolete under the proposed project.

G9. INVENTORY CARRYING COSTS

This term refers to the cost of operating a given volume of annual inventory and should reflect such expenses as storage, handling, record keeping, property taxes, insurance, etc. The term inventory includes raw material, in-process materials, and finished parts directly affected by the project.

(a) Obtain the standard percentage for inventory carrying (operating) cost from the local General Accounting Department. Apply this standard percentage to the value of the annual inventory of direct materials. This percentage should not include any "cost-of-money" factors.

Example:
If the annual inventory amounts to $150,000 and the reduction obtained by the project in question is $100,000, then the appropriate percentage, which in this case will be taken to be 15%, is applied to the $100,000. This means that a saving of $15,000 results from the reduction of inventory afforded by the project.

The 15% should not include any such cost of money item as an additional 3-1/2% of the $100,000 which might be obtained by investing it in bonds, other portions of the business or any other securities. Neither should it reflect a gain because the corporation did not have to borrow this money as it would have done if the project were not approved.

(b) The inventory carrying cost should be based on the average inventory value entered in J1.

Fig. 4—Sample excerpts from the Procedure Manual indicate type of guidance recorded for benefit of users of forms in the Uniform Economic Justification Procedure. The Manual is intended to assure standard use of the standard forms.

ing portion of the Economic Justification Procedure. Data collection may take up to 90 per cent of the analysis effort, whereas summarizing and calculating the data into payback and rate of return can generally be accomplished within 30 minutes. It is therefore of paramount importance that the data be based on accurate cost figures concerning the present method and on a reliable production forecast of future requirements.

The accuracy of the cost data representing the present method depends on how well historical information is provided on the existing assets. Good cost accounting practice is important not only for purposes of justification of a new asset but also for post-audit purposes after the new asset is acquired.

A reliable production forecast of at least five years is highly desirable particularly when justifying special purpose equipment. Where there is doubt concerning the stability of the forecast, the risk should be offset by a quick payback and high rate of return. Any production forecast showing a straight line requirement over the economic life of the project should be suspect as based on an average and should be challenged. A thorough check should be made to determine if the straight-line approach is realistic or whether prior experience with similar equipment indicates a variable production curve.

Each of the 19 cost items in Section G is carefully defined in the Procedure Manual and instructions are provided to tell the analyst where to find the cost data as well as how to treat them. This is illustrated in examples taken from the Manual, *Fig.* 4.

Although the rate of return may be high enough to indicate profitability of a machine replacement, savings may be due primarily to one or two inefficient situations reflected in the cost operating items. An accurate and systematic approach to cost correction can expose and pinpoint such cost items which then may be readily corrected, thereby avoiding a new capital investment.

▶ Annual Savings & Repayment of Investment

Savings are treated on an after-tax basis in Section H of the Computations Worksheet. Savings produced by a project contribute to the income of the company and are therefore subject to federal taxes at the 52 per cent rate. Any loss resulting from the retirement of present equipment is an accounting loss and is only considered for tax purposes. This loss, known as the write-off difference, is therefore added back to the net savings after its effect on taxes has been taken.

Similarly, depreciation difference is an accounting cost and is primarily considered for tax purposes. It, too, is added back to the net income (savings) after its effect on taxes has been taken. The result is an annual net income or repayment which can then be cumulatively totaled during the economic life.

Final calculations are outlined in Section J where the proposed capital investment is compared against the savings attributed to it. Here it can be noted that the form uses a return on average investment and payback as the elevation criteria. Average investment is defined as the investment that exists midway through the project. Because a fixed investment is periodically recovered through depreciation, a project's fixed investment gradually declines from original value to zero. Arithmetically, it represents the difference between the total investment and average depreciation.

Return on average investment provides a financial measure which can be compared against the company's minimum acceptable rate target. This minimum rate represents the company's ability to earn a return on its total investments. Projects earning less than this target rate may be rejected since they return less than the company's average earning experience. Projects earning above the minimum rate are ranked in ascending order to determine their relative worth in competing for the company's capital funds.

Much has been written in recent years on various summarization techniques, and it is not the purpose of this paper to evaluate their merits. Suffice it to say that each company must decide which technique is most compatible with its investment policies, whether it be discounting the cash flow of income to reflect the time value of money, or whether it be a simple averaging approach to rate of return.

THE AUTHOR

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HANDLING GYPSUM FOR GLASS FINISHING

CALCINED gypsum is being handled in bulk by a pneumatic system at the Nashville Glass plant of Ford Motor Co. The glass industry uses gypsum mixed with water as an adhesive to bind plates of glass to cast steel tables for movement under grinders and polishers. The usual method of handling gypsum in the glass industry is in bags. The Nashville installation is an example of the use of an automatic system to move bulk gypsum from railroad cars to storage bins and then to bins at the point of use.

After melting, rolling, and annealing, plate glass emerges in a continuous ribbon. After being cut into plates, it is moved to the grinding and polishing line. This line grinds and polishes the plate glass, one side at a time. The line provides a series of tables which move around a track formed by two parallel straight sections connected by curved end sections.*

At the point where one straight section begins is a gypsum application station. Two "day-use" bins at that point hold enough gypsum for a full 3-shift day. Gypsum is drawn from these bins as required and mixed with water to form a slurry. The slurry is spread on each cast steel table as it arrives at this gypsum application station. A crane then places a plate of glass on the table, and after the slurry sets, the table and plate are moved under grinders and polishers.

After the table and plate move to the other end of the line, the gypsum bond is broken, and the glass is separated from the table by air pressure. Another crane places the plate on a roller conveyor which moves it to a roll-over unit. This unit picks up the plate with suction cups and rolls it over 180 degrees, putting it down on a cast steel table ready to pass along the second straight side of the line.

There is also a gypsum application station near the roll-over unit. Two more day-use bins supply gypsum at this point for use in bonding the plate to a table with the second side of the plate up. After the slurry applied here sets, the table and plate move under the second battery of grinders and polishers. When the plate reaches the loading end of the line, it is finished on both sides and ready for transport to succeeding operations.

Automatic handling of the gypsum is performed by two pneumatic systems supplied by Fuller Co. One system conveys the gypsum from the railroad cars, in which it is received, to any one of five storage bins. The other system carries the gypsum from any one of the five storage bins to any one of the four day-use bins.

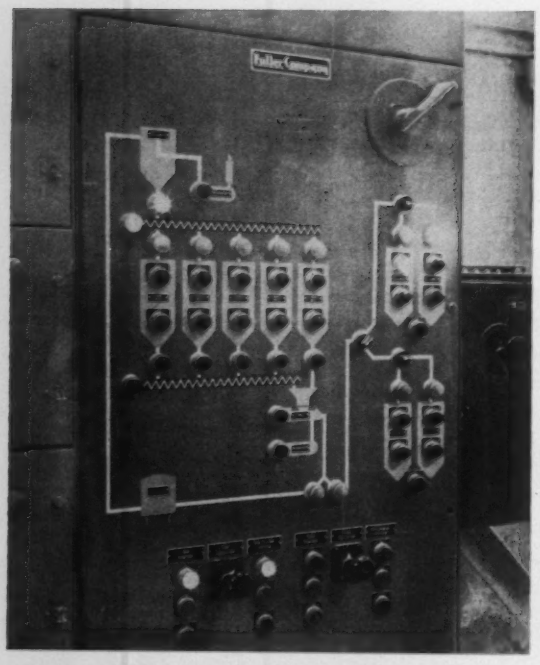
The first system moves material from boxcars, hopper-bottom cars, and General American Airslide cars to a filter unit above five bins of 65-ton individual capacities. A rotary airlock delivers gypsum from the filter to a screw conveyor that transports the material to any selected storage bin at a rate up to 14 tons per hour.

The day-use bins at the grinding and polishing line can each hold 18 tons of gypsum. When they require replenishing, a screw conveyor takes gypsum from a selected 65-ton storage bin and into a compression chamber. Air then moves the gypsum to the predetermined day-use bin.

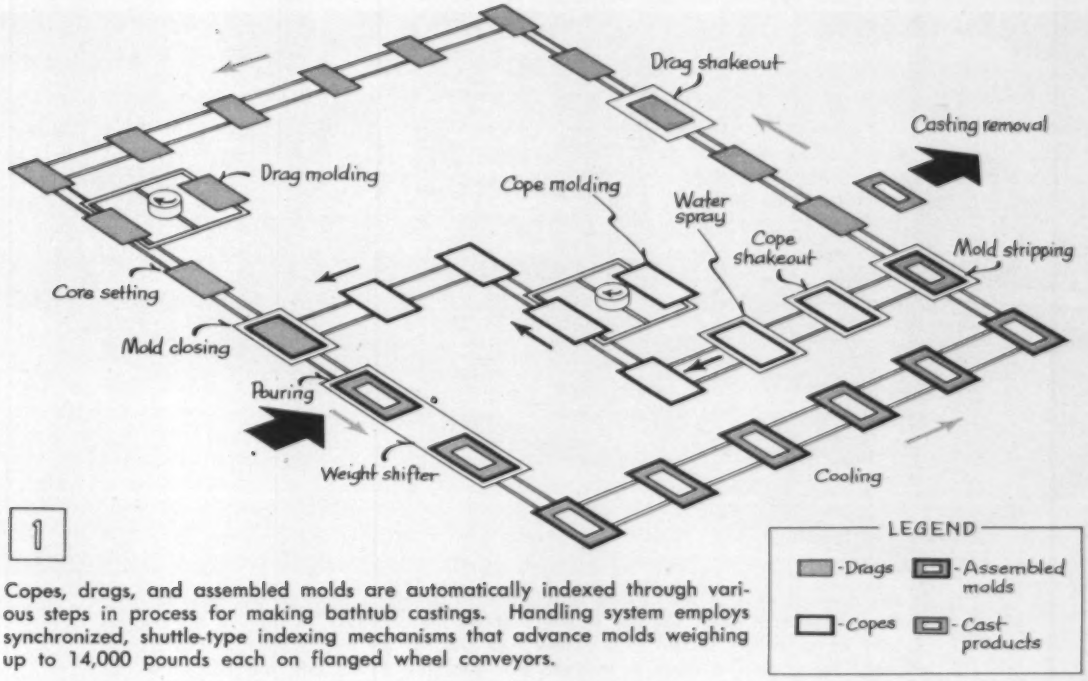
The entire handling system is controlled from a graphic control panel near the storage bins. Level indicators are provided in each bin to prevent overflow.

Although calcined gypsum is hygroscopic, there have been no problems with hydration in this bulk handling system even during the rainy season. Advantages of the system have led to decreased cost to provide gypsum at the desired points of use, cleaner operations, and reduced traffic and storage problems.

*See "Grinding and Polishing Plate Glass," AUTOMATION, Vol. 4, No. 11, November 1957, pp. 43-46.



Graphic control panel provides an operator with visual indications and complete control of bulk gypsum handling operations.



1

Copes, drags, and assembled molds are automatically indexed through various steps in process for making bathtub castings. Handling system employs synchronized, shuttle-type indexing mechanisms that advance molds weighing up to 14,000 pounds each on flanged wheel conveyors.

AUTOMATION TODAY

HANDLING LARGE MOLDS

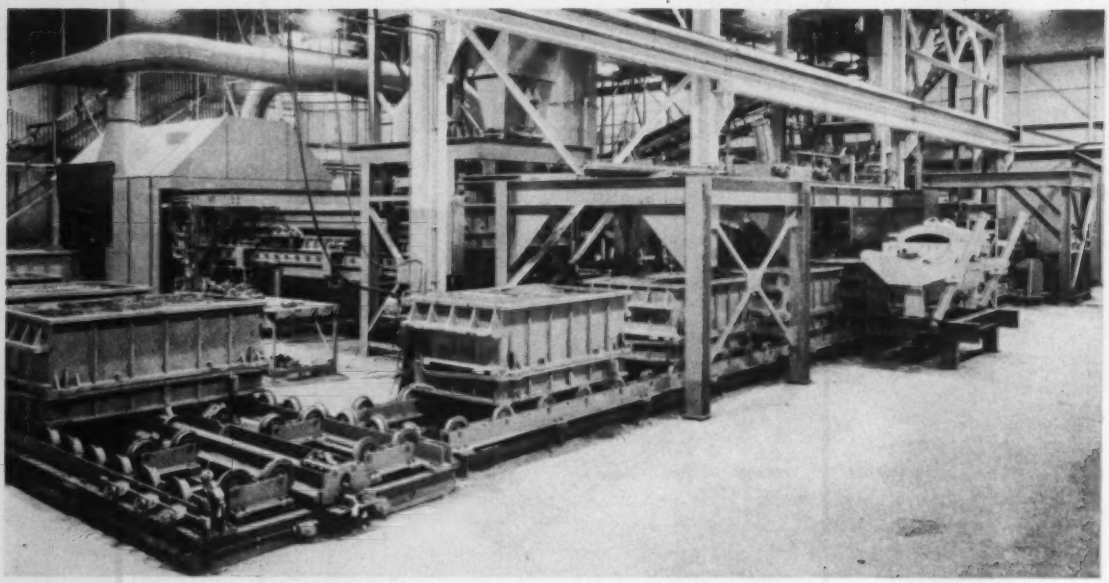
IN A BATHTUB CASTING FOUNDRY

PRODUCTION of 72 bathtub castings per hour is facilitated by an efficient handling system that indexes large sand molds through various steps in a bathtub foundry of Universal-Rundle Corp. Each completed mold including flasks, sand, and a casting weighs up to 14,000 pounds. The handling system that automatically moves copes, drags, and completed molds through the casting process was engineered, fabricated, and installed by Planet Corp.

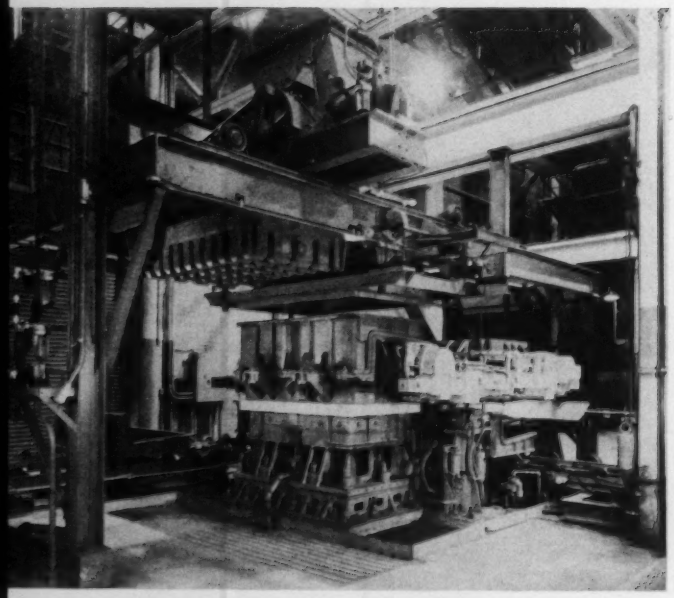
The mold handing system employs a series of flanged-wheel conveyors that support and guide the flasks and completed molds. Four conveyors of this type are arranged in a rectangle encompassing the molding equipment.

Indexing of molding elements on the conveyors is accomplished with a shuttle-type system that operates on a 45-second cycle. Major units of the indexing system are hydraulically operated shuttle and lock-bar mechanisms that can each move several flasks at one time. Basically, the mechanisms employ long-stroke hydraulic cylinders that advance and retract rotatable arms carrying dogs. Indexing occurs when a cylinder is operated with the arm turned so that the dogs are engaged with the flasks. The mechanisms are actuated by limit switches and their movements are synchronized. Flask indexing requires 7 seconds.

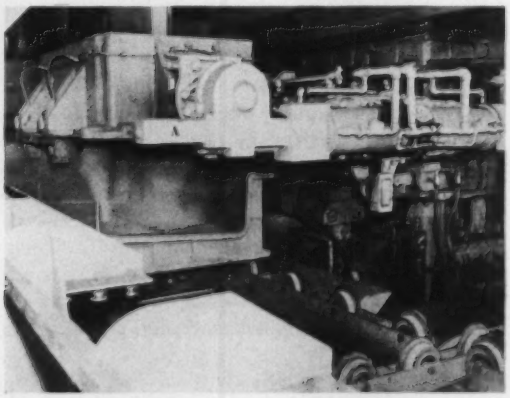
At a drag molding station along the conveyor, an empty drag flask that has been indexed into position is lifted and clamped to a fixture on a drag molding machine. As the machine indexes 180 degrees to carry the drag flask to a jolting table, the load is inverted so that the drag flask is on top with the fixture underneath. Simultaneously, a second fixture that was on the jolting table is indexed to carry a filled drag flask back over the conveyor. The filled flask is also inverted during the



2 In this over-all view of the casting installation, a pourer is seen on the floor in front of the conveyor at right. The low structure above the conveyor, in front of the pourer, is part of a weight shifter that places two weights on top of each mold before pouring. As a poured mold is indexed one position to the left, the weight shifter removes the weights. The mold then proceeds to the transfer point, left foreground, where it is directed to the lefthand conveyor for cooling. In left background, a mold is seen entering the mold stripping station. Hopper in center of photo supplies sand for cope molding machine.



3 Molding cycle begins at this Herman drag "Stationmaster" indexing unit. To prepare a drag, an empty drag flask is raised from the flanged-wheel conveyor at the drag molding station, right background. The drag flask is then engaged by a fixture carried on a pair of horizontal arms. Following an additional slight lifting motion, the arms index the fixture and drag flask 180 degrees to a position beneath the sand hopper in the center of the picture. Simultaneously with indexing, the fixture and drag flask are inverted so as to place the drag flask on top in the filling position. When the flask is filled with a metered quantity of sand, the metering box is shuttled off the flask and a series of heavy back-up weights (to left of molding machine) is moved into position for a jolt cycle. Following jolting, the weights are raised and returned to their original positions to allow indexing of the filled drag flask back to the conveyor. Inset shows an empty drag flask in position to be raised for engagement with a fixture on the indexing arms of the drag molding machine.



indexing motion so that the flask can be lowered onto the conveyor in its original orientation.

On the jolting table, the empty drag flask is filled with a measured quantity of sand from a metering box fed by a hopper. The purpose of the metering box is to ensure even distribution of the sand in the flask with minimum feeding of excess sand.

As soon as the flask on the jolting table is filled, the metering box is shuttled out of the way and heavy ramming back-up weights are placed over the flask. When jolting is completed, the back-up weights are raised and moved to a storage position. The drag molding machine turret then lifts the flask and fixture from the jolt table and returns them to their original positions above the conveyor. There, the filled drag flask is released and lowered onto the conveyor by a hydraulic lift.

In the next indexing position, cores are set manually in the drag flasks. After core setting, each drag flask is indexed to a closing station. Here, the drag flask is lifted hydraulically to meet a filled cope flask which is suspended over the conveyor by a cope setter. When assembly is completed, the closed mold is lowered onto the conveyor and moved to a weight setting and pouring station.

Upon receiving a 4000 pound weight at each end, the mold is poured with approximately 350 pounds of molten cast iron. It then indexes to the next station where the weights are removed automatically. Following this, the mold is transferred to a cooling conveyor and then to a conveyor leading to a mold stripper. As the mold proceeds to the stripper, an operator manually removes the sprue.

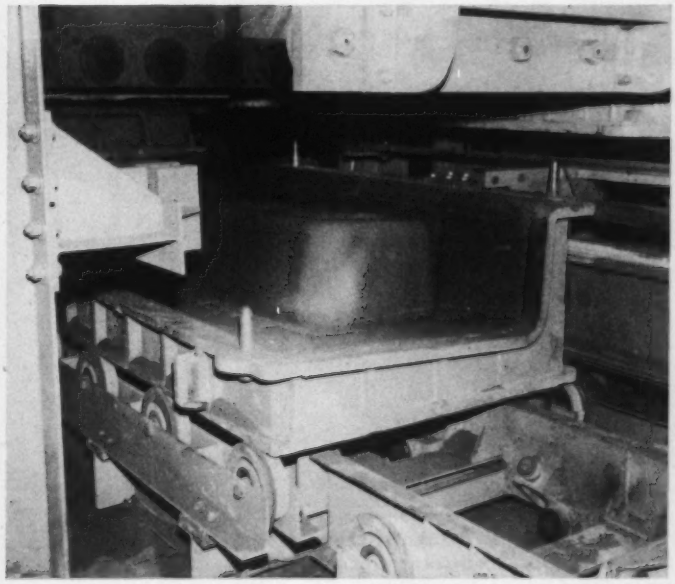
When the mold is shuttle-indexed to the stripper, a clamping mechanism lowers to grip the cope flask. The cope flask is then lifted off the drag flask and indexed through a cope shakeout and a water spray station. Following cleaning, the cope flask is moved to a cope molding machine for filling and return to the mold closing station.

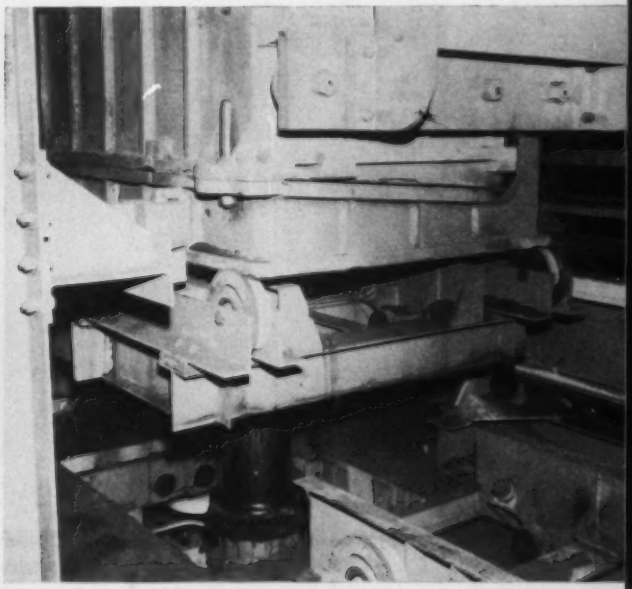
After the cope flask has been stripped from the drag flask, the drag flask is indexed to a casting removal station where the bathtub casting is pulled out by an operator using an overhead hoist. Drag flasks from which the products have been removed are next indexed to a drag shakeout and then returned to the drag molding station for filling.

Other facilities provided by Planet Corp. for the bathtub foundry include a sand handling system, a sprue handling system, and a casting cooling system.

The sand handling system has a capacity of 300 tons per hour and includes sand distribution and sand return sections. Sand mixes are prepared in 5000 pound batches in four automatically cycled mullers equipped with moisture sensing and control devices. Batch hoppers measure sand from 100-ton bins above each muller. When a batch is completed, it is released onto a trough belt conveyor in the basement of the foundry. The mixed sand is then elevated and discharged to the hoppers above the cope and drag molding stations.

Used and excess sand is collected below the shakeouts and molding machines by a combination of oscilating pan and belt conveyors. The conveyors elevate the sand and drop it onto vibrating screens



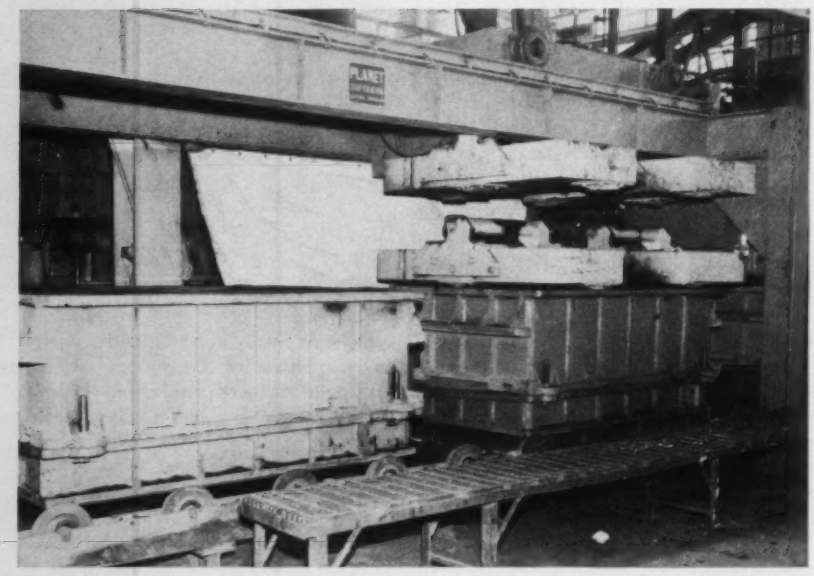


4 After the drag portion of a mold is completed and returned to the conveyor, it is indexed to a manual core setting station and then to the closing station shown. In photo at left, a drag is shown as it arrives at the closing station. As shown in photo at right, drag is lifted at this station until it engages a prepared cope that has been moved into position above the conveyor. When assembly is completed, the closed mold is lowered onto the conveyor and indexed to the pouring station.

above the storage bins associated with the mullers.

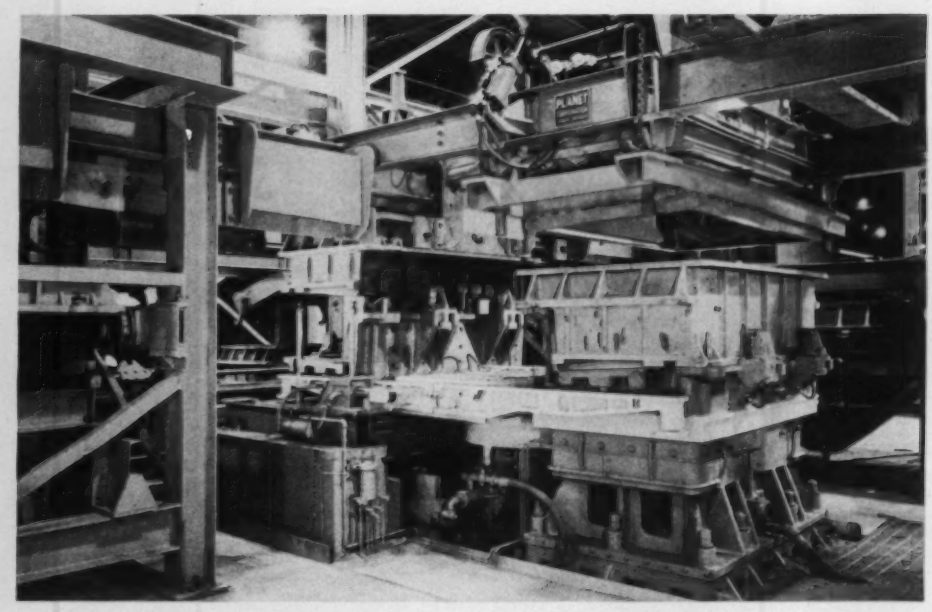
When the sprues and runners are pulled out of a mold, they are dropped onto a large oscillating pan conveyor under the shakeouts and placed in tote boxes. Filled tote boxes are transported to a central collection point by lift truck, then they are elevated by a skip hoist and stored in a scrap yard.

When the bathtub castings are pulled out of the molds, they are transferred to an overhead trolley conveyor which moves them through a casting cooling house. After the tubs have been cooled, they are delivered to a cleaning room.



5

Before a mold is poured in the station at right, a 4000 pound weight is placed automatically on top of it at each end. The two weights shown suspended above the mold were removed at the next indexing position to the left and have been brought into position for lowering onto the next mold to be indexed to the pouring station.



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Poured molds leaving the weight shifter are transferred to a cooling conveyor and then to a mold stripper. Drags proceed from the stripper to a casting removal station and then are shaken out and recirculated to the drag molding machine. Copes that have been separated by the stripper are shaken out and indexed through a water spray station for cleaning. Following cleaning, the copes enter the cope molding machine shown. This unit operates in the same manner as the drag molding machine except that heavy ramming back-up weights are not used for copes. From the cope molding machine, filled copes are transferred to the mold closing station where filled cope and drag flasks are assembled for pouring.

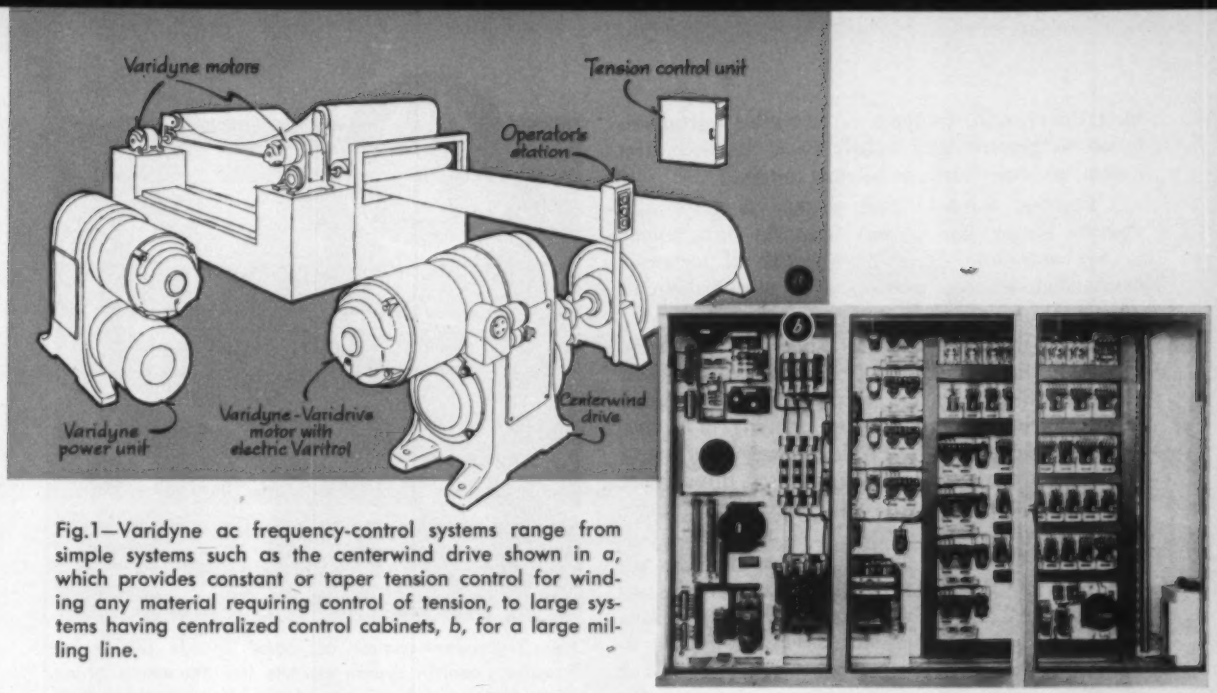


Fig.1—Varidyne ac frequency-control systems range from simple systems such as the centerwind drive shown in *a*, which provides constant or taper tension control for winding any material requiring control of tension, to large systems having centralized control cabinets, *b*, for a large milling line.

CO-ORDINATING DRIVES IN MULTIPLE MOTOR SYSTEMS

ALWAYS a serious engineering problem, co-ordinating speeds of drive motors on separate machines increasingly is met as a critical problem in automatic production facilities. Often, the degree of co-ordination must be within close tolerances in order to avoid damaging or destroying materials in process. Usually, machines to be co-ordinated are located adjacent to each other, however, it may be necessary to co-ordinate machines that are located in different areas of a plant. For example, co-ordinating the drive motors of separate conveying systems is a prevalent problem.

A basic tool that accomplishes these objectives, and offers other capabilities to designers of automated systems, is a U. S. Varidyne ac frequency-control system, *Fig.* 1, originated by U. S. Electrical Motors Inc. This system, using ac frequency as an "electrical lineshaft," not only co-ordinates the speeds of drive motors, but permits ultrafine changes of speed while running, equalizes the loads of the motors in the system regardless of size-differences, and lends itself to a number of special effects such as soft-start, extra-slow (threading) speeds, co-ordinated start-stop control, dynamic braking, etc.

The Varidyne system has been devised not only to provide variable co-ordinated speeds to automated systems, but also to utilize as its basic drive elements standard ac fixed-speed squirrel-cage motors. What makes it possible to produce variable speeds from this type of motor is the fact that its speed is always directly proportional to the frequency of the ac current supplied to the motor. Thus, if the frequency is varied, motor speed is likewise varied, and the degree of control is exact.

System Advantages

This type of speed control system is easy to apply in the design of either a plant production complex or an individual machine. The "electrical lineshaft" aspect of the system provides a degree of flexibility in the placement of drives and eliminates the need to compromise on such things as position, attitude, number, mechanical linkage, and similar limiting factors. Other advantages of the system include:

1. **Inherent co-ordination.** The system is inherently co-ordinated for multimotor applications. It needs no mechanical linkage or special instrumentation to start, change speed, and stop virtually "in step." Degree of simultaneity is ample for all ordinary applications. For applications on which precise synchronization is required, it can be provided by auxiliary instrumentation.

2. **Load equalizing.** The system is inherently load-equalizing for multimotor applications. It needs no

special devices for feedback or corrective instrumentation to prevent load imbalance or to disconnect system in case such imbalance occurs.

3. **Remote control.** The system is physically separate (except for wiring) from the drive motor to be controlled. Thus, it replaces all forms of mechanical linkage control with electrical-circuit control.

4. **Simplicity.** The control system is completely electrical and composed of standard off-the-shelf components. None of the components require special maintenance personnel, air conditioning of a control center, or other out-of-the-ordinary equipment. Standard ac three-phase wiring is used throughout, and any plant electrician who understands three-phase wiring can service it.

5. **Motor selection.** The system permits the selection of any three-phase ac motor—geared or non-geared, belted (including belt/sheaves units) or non-belted—with any degree of enclosure from open to explosion-proof or sealed construction, vertical or horizontal. Synchronous motors may be used for special applications, but are not needed for ordinary co-ordination requirements.

6. **Overspeed protection.** The system is inherently protected against drive motor overspeeds. Motors cannot "run away" inasmuch as frequency control limits motor speeds to the system speed. Speed is not dependent on load, but on the dial setting of the frequency-control power unit which is the basic system control.

7. **Quick starting.** No "warm-up period" is required. Motors come up to selected speed as soon as current is supplied. On multimotor systems, starting acceleration proceeds "in step" regardless of load differences, motor sizes, or ambient temperature differences at individual motors.

8. **Special effects.** The system is adaptable to provide a number of special effects and design refinements such as inching, jogging, thread-speeds, creep-speeds, soft-starting, dynamic braking, and position control.

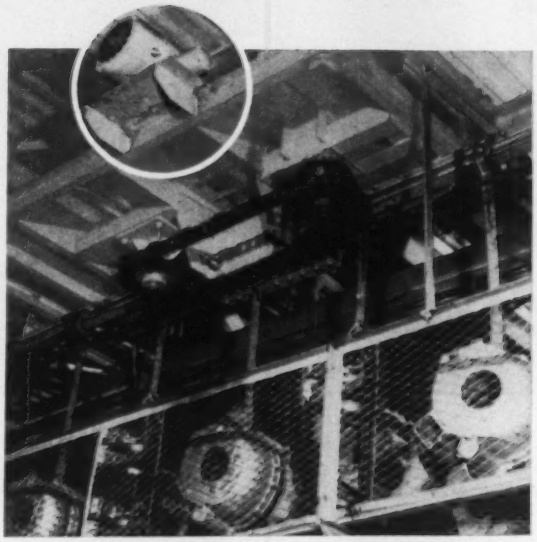


Fig. 2—Remote control of motor speeds by an ac frequency-control system permits the placement of ac drive motors in relatively inaccessible locations such as this mounting platform suspended below a plant ceiling. The reliability of standard ac motors keeps maintenance to a minimum, furthering the use of difficult-access locations.

9. **Environment.** The ac drive motors are inherently insensitive to environmental conditions. Rapid changes and extremes in temperature, unfavorable atmospheres, vibration, moisture, and other commonly encountered plant operating conditions do not affect them. Other extreme conditions can be designed against with readily available components.

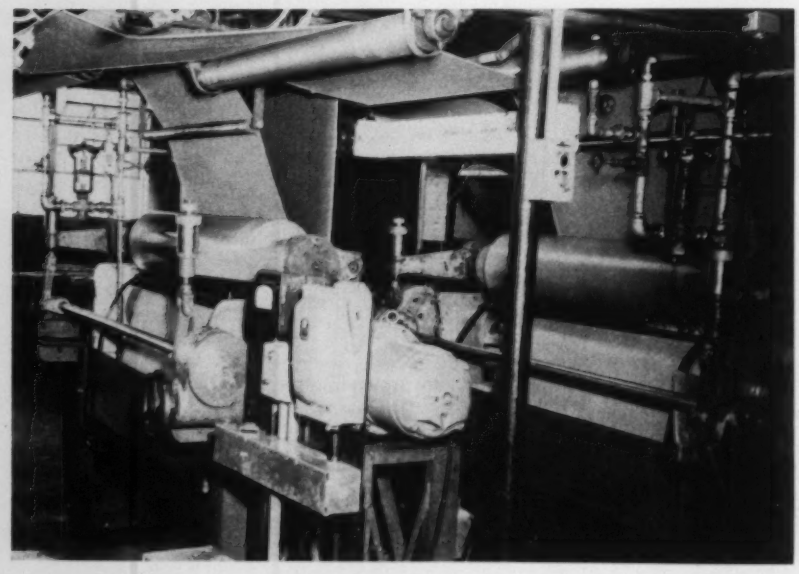


Fig. 3—Textile range drive is co-ordinated by a Varidyne ac frequency-control system which keeps "in step" 11 standard ac drive motors having horsepowers varying from 1½ to 5 hp. The system provides continuous speeds of 25 to 125 rpm and an intermittent slow threading speed of 12½ rpm. An average of 80 yards of denim are processed per minute.

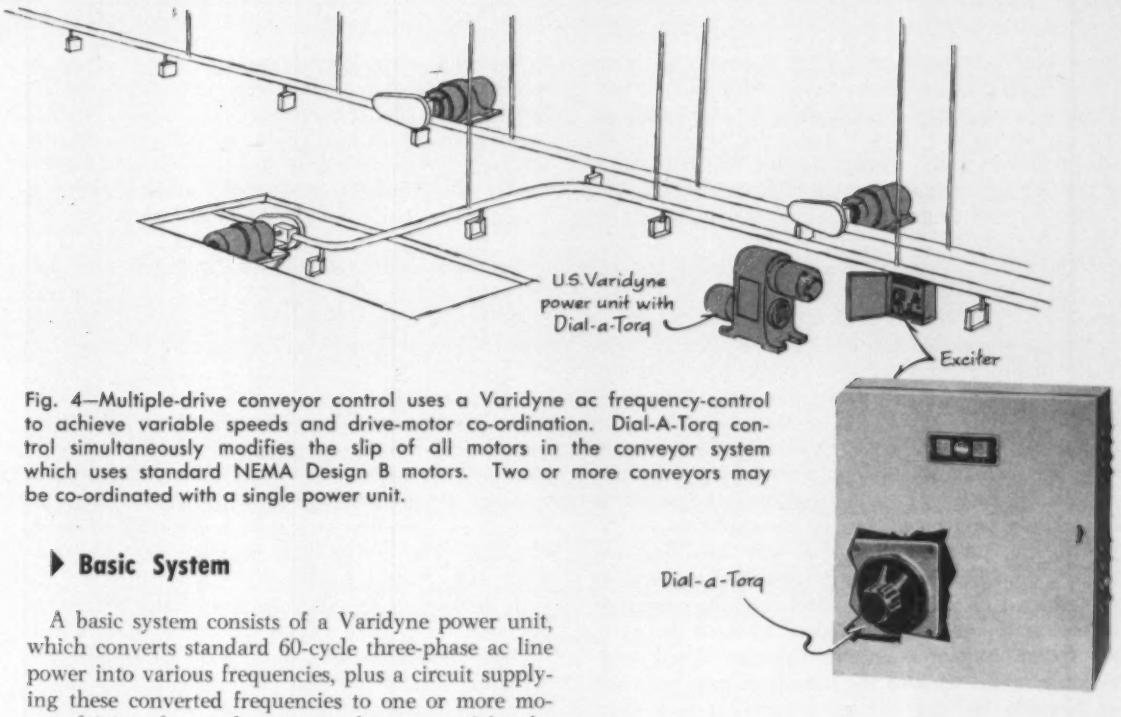


Fig. 4—Multiple-drive conveyor control uses a Varidyne ac frequency-control to achieve variable speeds and drive-motor co-ordination. Dial-A-Torq control simultaneously modifies the slip of all motors in the conveyor system which uses standard NEMA Design B motors. Two or more conveyors may be co-ordinated with a single power unit.

Basic System

A basic system consists of a Varidyne power unit, which converts standard 60-cycle three-phase ac line power into various frequencies, plus a circuit supplying these converted frequencies to one or more motors driving the machine or machines served by the system. Thus, the basic system provides a variable speed range which can be extended by special components. The power unit which converts the ac frequencies consists of a Varidrive motor (integral motor-belt-variable sheaves combination), alternator, and automatic exciter which are packaged to operate as a unit. Voltage is automatically regulated at starting and during frequency changes to operate standard ac induction motors. The speed of the power unit can be changed by manual, remote, or automatic controls.

By using standard ac motors an equipment designer can obtain superior flexibility in locating drive motors. Standard ac motors are light, compact, stable as to speeds and torque, simple, reliable, low in original and operating costs, and easy to work into a design because many locations and mounting surfaces are suitable to their size-and-weight versus hp requirement, *Fig.* 2.

The ability to co-ordinate and provide load-sharing in multimotor applications, *Fig.* 3, eliminates many design difficulties. Since frequency—unlike voltage—is unaffected by electrical resistances, it is not necessary to calculate and compensate for the various lengths of the motor supply leads. For co-ordinated stopping, it is not necessary to calculate WK^2 of each driven machine as well as the WK^2 of the rotor of the driving motor, insert an adjustable resistor in each slave motor line, and then tune in their co-ordinated stop by attempting to balance these factors. With a frequency-controlled system it is only necessary to calculate the torques and speeds within the range of the machine's usage, and install the type of motors required. The system "balances" itself through load-sharing, and the only speed regulation is through the line frequency. Line frequency remains at the value selected by operating the power unit control, regardless of environmental conditions. It maintains all motors in step regardless of differences in hp, inertial factors (rotor), machine loadings, and other variables.

This is also true throughout starting acceleration since any motor that has a high connected load and tends to lag would draw power from other lightly loaded motors. In stopping, the motors remain in step because the heavily loaded motors, tending to overrun, act as induction generators and feed power back to the lightly loaded motors.

Process Applications

A basic problem in many plants is that long conveyors require a multiplicity of motors which are located at different drive points along the conveyor's length. Under unusually difficult conditions, such as poor drive placement and inadequate slack take-ups, the motors may unequally share the wide fluctuations of load in the conveyor chain. To remedy this situation, an accessory called Dial-A-Torq, *Fig.* 4 can be used to adjust the torque capacity of all the motors in the system. In most applications, however, no accessory is needed with the Varidyne system since the load-sharing characteristic is sufficient.

Ordinarily the inherent co-ordination of the Varidyne system provides a practical degree of synchronization for multimotor applications. There are, however, applications that require extremely close synchronization, for example, at moving conveyor exchanges where work-in-progress must be picked up from a conveyor at a predetermined point within very close tolerances and without cumulative error. The pick-up is usually by a moving machine or another moving conveyor, and the matching of speeds must be exact. This type of problem can be solved

by a LinkSync position control. Split-second pick-ups of fragile material can be provided from a conveyor to a machine having rapidly revolving pick-up arms in which lack of synchronization would shatter the product. A position control system can give a high degree of satisfaction in such a critical application. Other position control applications are in operation for such uses as a body-drop in the automotive industry, a dip process in plastics, automatic assembling, stamping, drilling, etc. For such systems, standard ac synchronous motors are used.

Machines employing range drives which process a continuous web of material (fabric, plastic, metal, paper, etc.) may have many motors, all performing work on the same piece of material. The speed of each drive motor must be adjusted individually in order to maintain the proper tension, or a "no-tension," drive for the web, *Fig.* 5. Such individual drive-speed adjustment can be accomplished by replacing the standard ac motors with an integrated motor/belt/adjustable sheaves combination such as a Varidrive motor. Thus, speeds at those particular drives can be adjusted, and once adjusted the overall system control maintains the new speed relationship no matter how the line-speed may be raised or lowered by the frequency-control power unit. Where desired, the system will maintain the speeds of the various motors in an exact predetermined proportion, instead of at equal speeds. Gearmotors may be used in conjunction with standard motors and Varidrives without sacrificing either synchronization or load-sharing. In many systems, speed adjustments can be made from a remote control panel by means of electrical remote control plus remote speed indicators.

Where variations in the material or the process are functions of drive-motor speeds, it is possible to automate applications so that the material-in-work will alter drive-motor speeds to maintain the process within predetermining tolerances. Such tolerances may be set much closer than is feasible for manual control operation; and considerable savings in material, time, rejects, and manpower may be achieved while upgrading the uniformity of the finished product.

Automation of a production process in this manner requires a sensing device such as a tensiometer, dancer roll, float, or other instrument capable of transmitting a signal—preferably in terms that reflect the degree of correction needed. The signal of the sensing device can be transmitted by mechanical, pneumatic, electrical, or electronic means back to the motor speed control where it can be used to effect a shift of control in such a manner as to increase or decrease motor speed, according to the direction in which the process is deviating from the ideal. In such systems it is possible to maintain close tolerances for such production variables as: Pressure, temperature, humidity, torque, viscosity, tension, weight, position, liquid level, cutting speeds, grinding speeds, flow rate, surface speed, filtration rate, drying rate, machine tool programming, and conveyor speeds.

In employing an ac frequency-control system, a designer has a wide variety of variables on which to base the automation of a plant process or the operating factors involved. The systems lend themselves to programmed machine operations, particularly in those instances where point-to-point transfer of materials must be accomplished with extreme accuracy and without cumulative error.

In most applications, system components are standard three-phase electrical equipment, readily obtained and easily understood by plant electricians. Since a system contains a relatively small number of components, downtime occurs less frequently and is of much shorter duration than with more complicated systems. The system's inherent protection of driven machines against motor overspeeds is a factor for simplicity as well as safety. Motor speeds, under frequency-control, cannot exceed the system speed as determined by the power unit. Hence there is no need to provide each motor with an overspeed safety device.

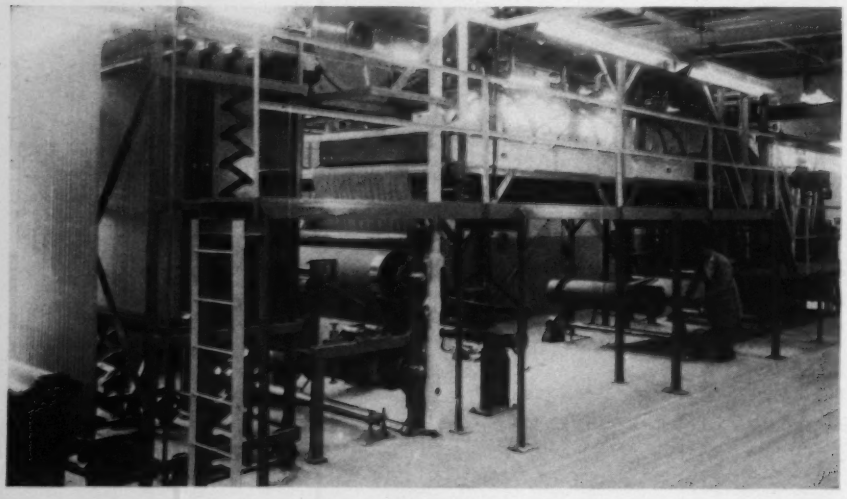


Fig. 5—Plastisol coating line, viewed from the winder end, provides an example of automatic tension control by an ac frequency-control system. The system co-ordinates motor speeds throughout their range regardless of changes in line-speed. Once the desired tension is achieved, no further adjustment is necessary, and tachometer feedback is not required.

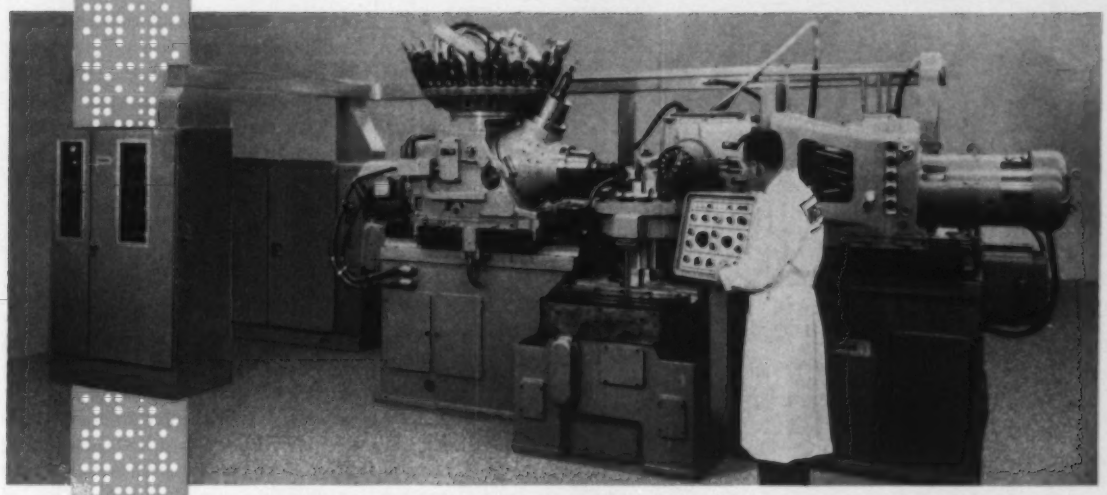


Fig. 1—Tape controlled machining system is designed to provide flexibility of operation for the job-shop manufacturer. In the configuration shown, the central worktable is surrounded by a universal tool changing head on the left, a face milling head in the rear, and a ten-spindle drill head on the right. The electronic control cabinet for the system is at the extreme left.

TAPE CONTROLS MULTIHEAD SYSTEM

Aimed at job-shop type of manufacturing, a new machining system combines the advantages of numerical control, automatic tool changing, and multiple work heads. The result is a versatile and productive system that automatically produces parts.

By **CARL B. PERRY,** Product Manager, Industrial Systems Div., Hughes Aircraft Co., Los Angeles, Calif.

NECESSITY to obtain maximum productivity has warranted major investments in greater mechanization in those industries where large volume production is involved. Great strides have been made in reducing through mechanization the nonproductive time of a machine or system and the physical efforts required of its operators. In some cases, this has been accomplished quite simply by applying special work handling devices which select, orient, and present work to a machining operation. In other cases, mechanization has required the development and application of special single-purpose machines.

Progress in this direction, however, has demanded that the quantity of work be large and justification of machine cost be obtained through long and steady job runs. A major field that has been neglected in this process of mechanization is the field of job-shop manufacturing. In this field where production runs are usually short, cost savings to justify major equipment investment are often hard to come by. The advent of numerical control has changed this picture in a drastic and impressive manner.

Defining the Need

Looking back, the major steps in the development of numerically controlled positioning systems have been:

1. The original development of a two-axis positioning system provided an automatic means of locating sequentially selected points on a plane in relation to a tool spindle center line.

2. The addition of a third axis of control automated spindle movement into and away from the workpiece.

3. The replacement of a single spindle on a machine with a turret type indexing spindle allowed automatic tool selection.

4. The development of a tool storage and automatic inter-

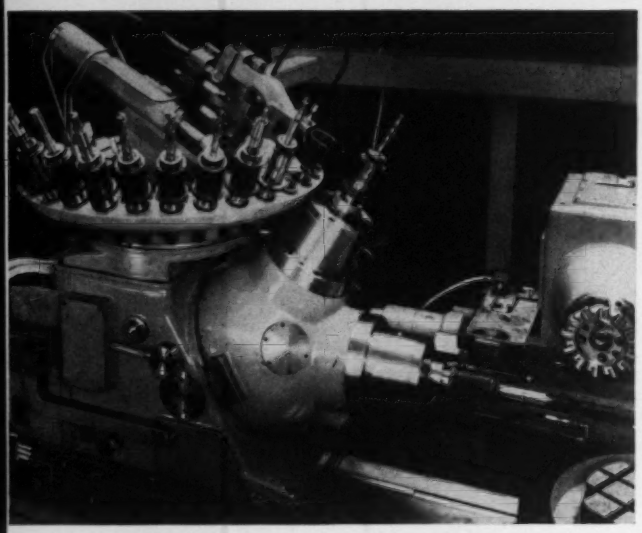


Fig. 2—Tool magazine of the universal head holds up to 30 tools. A two-spindle turret receives and engages each tool with a workpiece on the positioning table. While one tool is being used to machine the workpiece, the previous tool is unloaded from the turret spindle and a new tool is inserted in the spindle. Upon command from the tape control, the turret indexes the new tool into position in less than 3 seconds.

changing system further increased the number and variety of tools that could be applied to the workpiece.

5. Versatile work tables were developed having the capability of rotating the workpiece so that various faces of the part could be presented to a single work station or spindle.

These concepts have been applied to many types of numerically controlled machines which are available on the present market. However, job-shop manufacturing usually requires more operational flexibility than can be provided by single spindle numerically controlled machines. Therefore, the Industrial Systems Div., Hughes Aircraft Co., instigated a complete analysis of application requirements to determine the type of numerically controlled machine and desirable features that would be ideally suited for job-shop manufacture.

An extensive survey of typical shops within the metalworking industry was undertaken to establish basic design criteria for an advanced numerically controlled machining system. This survey included factors such as part sizes, part configurations, materials, cutting tool requirements, etc. A statistical analysis of the survey results revealed that a very large percentage of all job-lot production parts produced by American metalworking industries are containable in a 12-inch cube.

Analysis of the sizes and types of cutting tools required indicated that the compromises inherent in operating different cutting tools in a single spindle were self-defeating. For example, small drills require high rpm, low horsepower, and apply low forces on spindle bearings. However, large diameter milling cutters require low rpm, high horsepower, and apply large forces on spindle bearings. An ideal machining system should have more than one spindle, and each spindle in the system should be designed around the specialized requirements of the types of cutting tools it would support.

The survey also disclosed that it was essential that the skills required to apply a machining system be compatible with those skills normally available in an average small job-shop. Such a system should be simple to program, operate, and maintain. And finally, the machining system must be delivered at a price suited to the economy of the potential users.

System Hardware

The surveys of metalworking industries established criteria that led to the design and configuration of the numerically controlled machining system shown in *Fig.* 1. This system consists of a central section, containing a worktable 18 inches in diameter, surrounded by 1, 2, or 3 base and machining head assemblies. For example, in the configuration shown a universal tool changing head is on the left, a milling head is in the rear center, and a ten-spindle drill head is on the right. A single spindle precision boring head with an automatic tool changing system can be used in place of the drill head, depending upon a user's particular requirements.

Since the head and base assemblies are designed around the building block principle, the design concept provides a productive and versatile machining system which possesses the ability to grow and be modified as product requirements change. For example, the system can be an integrated functioning unit with only the central worktable section and the universal tool changing head. In this configuration, a wide range of parts that do not require heavy milling or large bored holes can be processed. When the need arises, additional heads may be added. Therefore, the ultimate potential of the system can be obtained in stages as economic justification permits.

The fundamental precept of the machining system is to obtain the optimum use of machine time. Those factors which normally combine and add to the cost of manufacture without performing any useful function on the product have been mimimized or eliminated. Manual handling, positioning, selection of feeds and speeds, changing tools, etc., have been automated so that the system can perform at maximum efficiency and frequency. For example, studies indicate that conventional general-purpose machine tools are cutting metal only 25 to 35 per cent of the time when using high-speed steel tools and only 15 to 20 per cent of the time when using carbide tools. The Hughes system will cut chips better than 75 per cent of the time.

This increase in machine utilization time is partially obtained by means of the tool changing system on the universal head, *Fig.* 2, which permits tools to be interchanged in less than three seconds. On this head, high-speed tool changing is accomplished by a two-spindle turret. While one spindle is engaging a tool on the workpiece, the second spindle is in position to receive a new tool from the tool storage magazine. Therefore, the machine does not stand idle while a tool is being removed from the

spindle, carried to the turret, a new tool removed from the turret, and carried back to the spindle. The only downtime is the few seconds required to index the spindle turret, bringing the new tool into play and removing the old tool. Up to 30 tools as large as 3½ inches in diameter can be stored in the tool storage magazine.

When a workpiece requires heavy milling, it can be positioned by the table in the working area of the rear center milling head which will hold up to an 8-inch diameter milling cutter. This head gives the machining system significant advantages over single spindle tool changing systems which usually cannot effectively apply large diameter milling cutters because of limited driving torque. Spindle speed of this head can be varied from 60 to 2400 rpm in 28 steps, and horsepower available at low spindle rpm is excellent. For example, when the spindle is turning at 133 rpm, the head has a 10 hp rated input. The spindle is designed to withstand substantial side forces that large milling cutters transmit to the spindle bearing system.

The third work head can be either a ten-spindle drill head or a tool changing precision boring head. The drill head is useful in cases where a large number of deep holes in material difficult to drill is required. It will produce up to 10 holes in the time required for a single spindle to produce one hole. The optional boring head is provided with a tool storage magazine having a capacity for storing up to 14 preset boring bars with sizes ranging up to 6 inches in diameter. Its tool changing system is equipped with a ready position to minimize downtime during tool exchanging. The spindle nose and tool holders are designed to repeat the initial radial registry of the tool as it is inserted in the spindle nose. This registry assures that the minimal run-out of the precision spindle bearing system will not result in a critical change in the diameter of holes as a result of tool removal and reinsertion.

All heads of the system are serviced by an 18-inch worktable in the central section. This table has three modes of motion: Vertical through a range of 12 inches, transverse through a range of 24 inches, and rotary to 16 discrete index positions. The head assemblies on either side of the base section have 19 inches of travel, and the milling head has a 24-inch lateral travel. All heads except the boring head have 31 different programmed feed rates, ranging from 1 to 75 inches per minute and a rapid traverse rate of 150 inches per minute. The boring head has programmed feed rates varying from 0.5 to 37.5 inches per minute and a rapid traverse rate of 75 inches per minute.

▶ Operating Features

Movement commands are expressed incrementally, that is, the distance to be moved from one point to another rather than the distance from machine zero. Incremental programming has proved to be easier for a programmer and permits the use of simpler electronic logic circuits. The commands are expressed in decimal parts of an inch to increments of 0.001 inch and are translated onto tape by means of standard tape preparation equipment. The format and binary decimal code used is compatible with AIA and EIA standards.

Movements along the axes are produced by hydraulically driven ball nut lead screws. Position feedback is obtained by magnetic transducers which are coupled to all leadscrews. The output from these transducers is converted to a square wave pulse for every 0.001-inch of movement. Commanded movements are expressed as a pulse count which is automatically counted down to zero as movement is executed. As the desired position is approached, the servo system executes a three-step slowdown, terminating at a final approach speed of 1 inch per minute. Feed rates are controlled by monitoring the output of dc generators attached to the leadscrews and comparing these voltages against reference voltages established by a resistor bank.

Selection of tools from the tool storage magazines of the universal head and the boring head is based on identification of tool location in a magazine rather than coded tool holders. Using a mechanical and electrical system of five cams and switches each of 30 tool storage locations is identified by a binary code. The part programmer assigns location numbers to the tools by writing their description in numbered blanks on the planning manuscript. In this manner, it is not necessary to provide any physical identity to the tool holders since the placement of the tool in the proper location of the storage unit accomplishes this purpose. Therefore, standardized low cost tool holders can be used and no necessity exists to preset or carry a large number of coded holders in inventory.

Maintenance of the machining system can be accomplished by personnel of a skill level found in small job shops. The system has been designed to free the user from depending on outside service organizations for system repair. This objective was accomplished by modularizing all electronic circuits. This approach to system design means that the probable frequency of electronic failure is extremely low and, should failures occur, repairs may be made by identifying the defective module and replacing it.

Operation of the system is simple. Generally speaking, the skill required to operate the system is considerably lower than that required to operate conventional universal machine tools. The operator performs the following tasks: Inserting and removing the tape from the reader, mounting and removing the fixture on the worktable, loading and unloading the part into the fixtures, inserting and removing cutting tools from the tool storage magazines, and general surveillance of the machine and cutting tool performance. Usually, one operator can service two machining systems on normal job-lot production work. The operator's spare time, if only one system is used, can be used to perform secondary operations such as burring parts and setting up tools and fixtures for the next production run.

Job-lot machined part manufacturing is at the crossroads, and the opportunities available are limited only by the rapidity with which industry and management can change to meet the challenge.

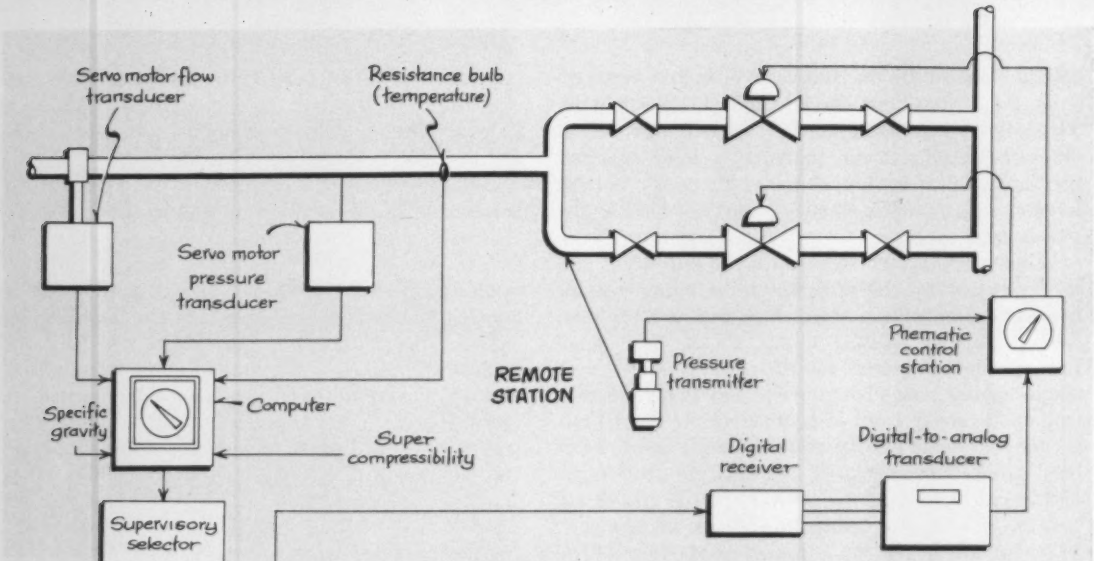
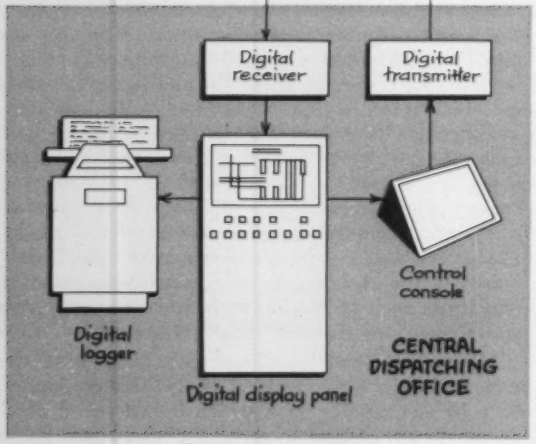


Fig. 1—Diagram illustrates a typical information and control circuit used in a gas dispatching system at Peoples Natural Gas Co. Pressure, temperature, and flow data are sensed at remote metering and regulating stations and are telemetered to a central dispatching office. Here, the information is displayed in digital form on indicators below plastic panels presenting the pipeline layouts at the remote stations. The gas dispatcher can change set points and alarm points, open and close valves, and adjust regulators at the remote stations by means of the control console.

CONTROLLING REMOTE STATIONS

IN GAS DISTRIBUTION SYSTEM



GAS USAGE varies continuously depending upon the time of day, season of the year, type of weather, and level of business activity. A gas dispatching system must cope with these variables and ensure that sufficient quantities of gas are obtained from sources of supply to maintain proper pressures in every line of a gas company's extensive distribution system. A gas dispatching system, *Fig.* 1, which incorporates the most up-to-date techniques of automatic and supervisory control has been recently installed by Peoples Natural Gas Co., a utility serving Pittsburgh and 273 other western Pennsylvania communities.

In order to obtain an adequate supply of natural gas at minimum cost, the company's system is connected to four major pipeline suppliers. Contractual

and economic considerations limit the rate at which gas can be obtained from these primary sources, and the company supplements those supplies with gas from its own local fields, purchases from local producers, and withdrawals from underground gas storage pools. It is the function of the gas dispatcher to monitor all gas flowing into the company's system and to continually make adjustments to valves and regulators so that the gas is fed into the user distribution system at properly regulated pressures and flows.

Several years ago the company decided that some form of data accumulation equipment was needed in the existing gas dispatching system in order to efficiently and economically handle increasing gas usage. At that time it was planned to telemeter local pressure and flow information to a central point in each of the company's six divisions.

As gas usage continued to increase and necessitated additional changes in the piping system, more stations were involved. It was then decided to abandon plans for a divisional setup and concentrate on a system-wide setup in which the various units would transmit data to a central dispatching office. It also was determined at this time that remote control of certain equipment in the system would increase the use efficiency of the pipelines and permit the central dispatching office to exercise complete control over the entire system. Therefore, with close cooperation of the Bristol Co., Westinghouse Electric Corp., and Peoples Natural Gas Co. a system has been developed which represents an advanced technique in measurement, control, and telemetering for gas dispatching.

▶ Remote Station Operation

Key point of the entire gas dispatching system is the central dispatching office, *Fig.* 2, which is located in the main offices of the company in downtown Pittsburgh. From this office the dispatcher exercises automatic remote control over five major metering and regulating stations, *Fig.* 3. Two of the stations are over 60 miles from the dispatching office, and three stations are in the suburbs of Pittsburgh. Pressure, temperature, and flow data are automatically telemetered from the stations to the central office via leased telephone lines. In addition, the dispatcher can remotely operate regulators to increase or decrease gas pressures and can remotely open and close gate valves at the stations to shut off or re-route flow of gas.

A tabulation of the measurement and control functions handled between the dispatching office and the five remote stations is shown in TABLE 1. In addition, several measurements from one of these stations are reported to and many functions controlled from a subsidiary dispatching center which handles the dispatching of gas to the city of Pittsburgh. However, this subsidiary center operates under the direction of the main dispatching center.

At each of the remote metering and regulating stations gas pressure, flow, and temperature measurements are converted into electrical signals by Bristol servomotor-operated transducers, *Fig.* 4*a*. To reduce the number of transmitted signals and eliminate manual computations at the dispatching center, the pressure, flow, and temperature signals are then fed into analog totalizer computers, *Fig.* 4*b*, where corrections are made to the readings for specific gravity

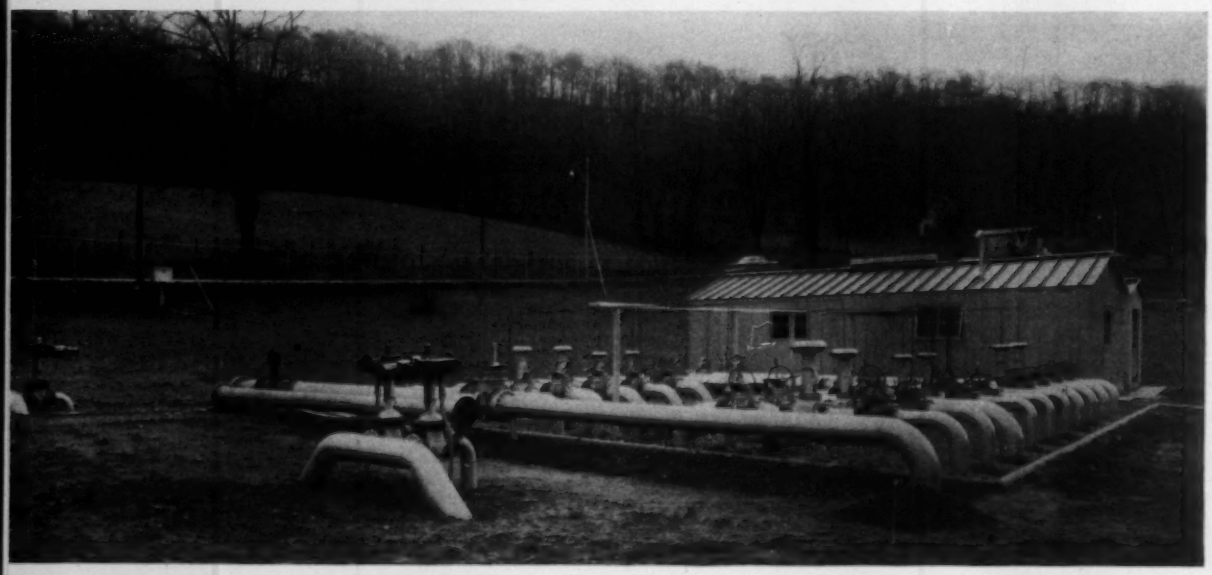
Fig. 2—General view shows the central dispatching office at company headquarters in downtown Pittsburgh. On the left are five control cabinets with plastic piping diagrams and digital indicators for the remote stations. On the left corner of the desk is the control console by which the dispatcher exerts control over the system. The data logger for automatically recording readings on demand or at specified intervals is at the right end of the dispatcher's desk.

and super compressibility constants of the gas. The data is then fed to a Westinghouse supervisory panel, *Fig.* 5, for transmission to the dispatching center.

In the supervisory panel a selector sequentially connects each measurement signal to a digital voltmeter for conversion into a digital code. A five bit binary code with a self-checking feature is employed. When a coded signal is telemetered to the center, the correct number of short and long bits must be received as well as the correct total number of bits before the signal is accepted as a valid code. As a further safeguard, each selection of a control point and each request for information by the dispatcher must be answered by a duplicate code from the selected station before the operation is completed. This check-back gives the dispatcher a check on the accuracy of his operation as well as establishing a safety check on the accuracy of the supervisory and communication equipment.

In addition to its measuring function, each pressure measuring instrument is equipped with remotely set alarm contacts which alert the dispatcher via digital coded signals when a measurement exceeds a desired value. As these values need to be changed due to varying loads or conditions, the dispatcher can reset the contacts to new alarm points from his control console. All other measuring instruments are equipped with deviation contacts which initiate a digital signal to the dispatcher when a reading varies from a set value.

Fig. 3—The remote metering and regulating station at McKeesport is shown. The two isolated piping clusters in the left foreground contain main throttling valves equipped with remotely controlled valve operators. On-the-site control equipment for this station is located in the two buildings in the right background.



Dispatching Center Operations

From the remote stations, digital signals are telemetered over leased telephone lines to receivers at the dispatching center. These digital receivers are located in five equipment cabinets with each cabinet controlling the functions at one of the remote stations. Facing the dispatcher on each cabinet is a plastic panel, *Fig.* 6*a*, containing a piping diagram which graphically depicts the actual piping and valve arrangements for the particular station. For example, a valve is shown symbolically in the diagram, and its state at any time is indicated by one of two lights within the valve symbol. Depending upon which light is lit, the dispatcher knows whether the valve is open or closed. A third light within the symbol is lit when the dispatcher is in direct communication with the valve through the telemetering system. Other lights in the panel show deviation points, alarm points, measurement points, and condition of the communication channels.

Immediately below the piping diagram on each cabinet are digital indicators which continuously display all readings being received. On those measurements for which set points can be remotely controlled by the dispatcher, a second digital indicator showing the set point is located immediately above the measurement indicator.

To provide a record of the dispatching operation, an International Business Machines Corp. data logger is used to automatically type all received readings at specified intervals or on demand. Points that are in alarm condition are typed in red. This equipment saves the dispatcher the labor of manual logging and leaves him time for study of the system

TABLE 1—Measurement and Control Functions

Function	Chalfont	Blackhawk	Remote Station McKeesport	Mt. Royal	Vinco
Pressure measurement	3	4	6	4	3
Computed flow measurement	4	2	2	1	2
Temperature measurement	0	1	0	0	0
Remote control set point	0	1	5	0	1
Remote alarm set	3	4	6	4	3
2-way remote valve operation	0	2	0	1	0
Throttling valve operation	3	1	5	5	3
Bi-directional flow	1	0	0	0	0
High and low alarms	3	4	6	4	3
Deviation indication	0	1	5	0	1
Total functions	17	20	35	19	16

and control functions.

All control and demand functions are initiated from a Westinghouse control console, *Fig. 6b*, located on the dispatcher's desk. From this point the dispatcher performs all the supervisory functions such as: 1. Call for any reading in the system on demand. 2. Update all digital indicators without a log. 3. Update any single station's indicators without a log. 4. Institute a manual log cycle. 5. Select a controller and set its control point. 6. Select an alarm instrument and reset its alarm contacts to a new position. 7. Select and operate 2-way valves in system. 8. Select and operate 3-way throttling valves.

To change the set point of a remote regulator, the dispatcher first pushes the proper point of control button on the control console. For example, under the *McKeesport* column, he may push the button marked *Regulator P-218*. On the panel diagram for this station, a light will illuminate at the selected regulator showing that telemetering contact has been established. The dispatcher then sets a digital indicator on the control console to the new desired control value. After a series of automatic checks which ensure against operating the wrong regulator and against transmission of an incorrect command, the dispatcher presses a button marked *Send Set Point* which telemeters the new control point. At the remote station the telemetered signal is received at the Westinghouse supervisory panel, converted into a pneumatic signal by a Bristol pneumatic transmitter, and sent to a Bristol Metagraphic con-

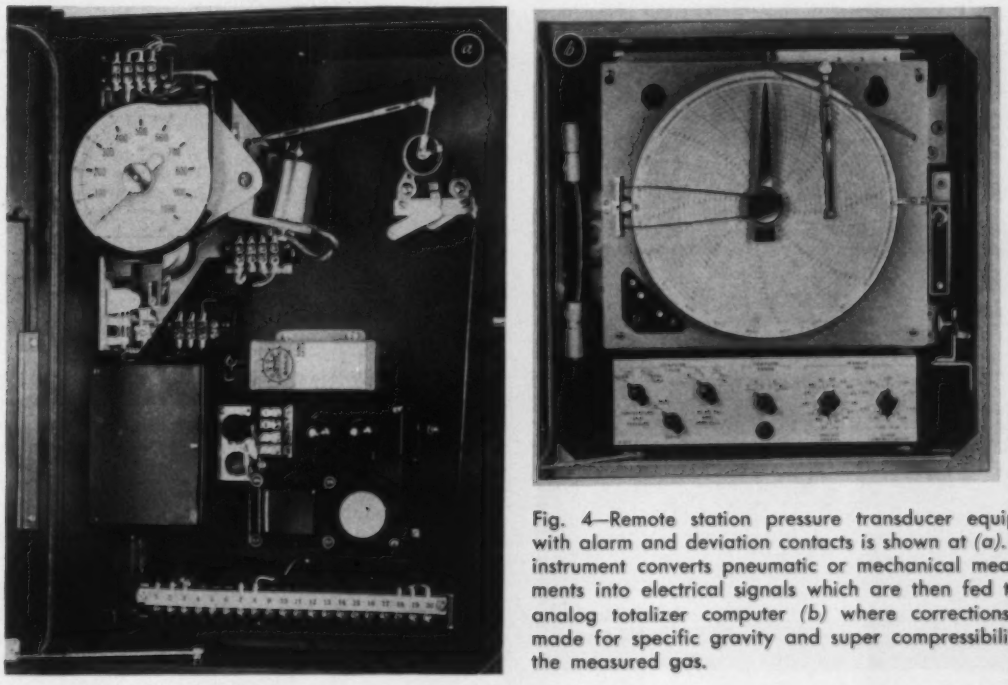


Fig. 4—Remote station pressure transducer equipped with alarm and deviation contacts is shown at *(a)*. This instrument converts pneumatic or mechanical measurements into electrical signals which are then fed to an analog totalizer computer *(b)* where corrections are made for specific gravity and super compressibility of the measured gas.

troller which adjusts the regulator to the desired control point. The dispatcher knows that the adjustment has been made when the digital indicator on the control panel at the center reads the new control value.

To operate valves in the remote stations, the dispatcher's control console contains selection buttons for each valve under the proper station column and two command buttons for either *Open Valve* or *Close Valve*. By a similar system of coded signals and check backs as previously described, the dispatcher can select a station and perform a desired operation of opening or closing a valve.

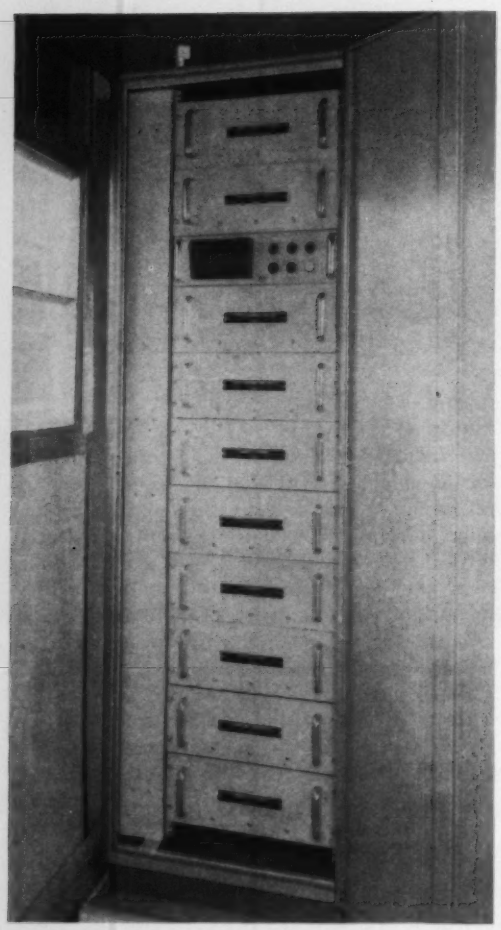
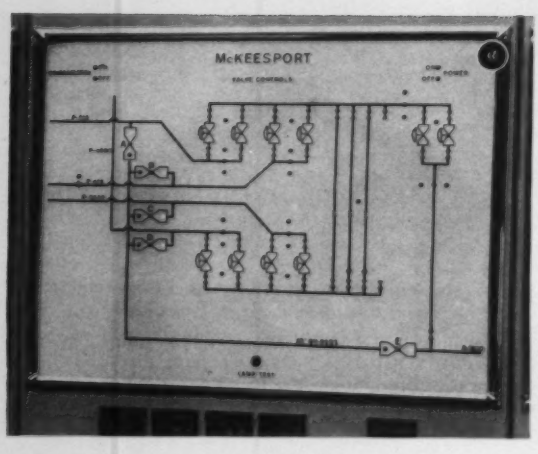


Fig. 5—Supervisory panel at the remote station converts the corrected signal measurement into a digital code for transmission over leased telephone lines to the central dispatching office. When the dispatcher needs to correct set points, adjust regulators, or change valve settings, digital code from the control console in the dispatching center is telemetered back to this supervisory panel for conversion into operating signals to effect the desired control action.



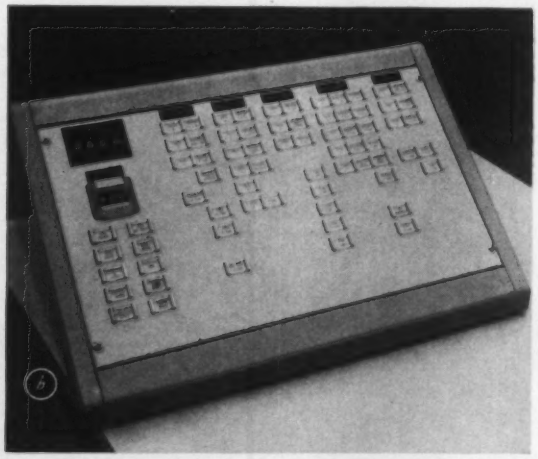


Fig. 6—Closeup view of a plastic piping diagram on a control cabinet at the dispatching center is shown in *(a)*. Immediately below the panel are the set point indicators for pressure points at the remote station. The dispatcher's control console is shown in *(b)*. In five columns on the right section of the console are the function control buttons for each of the remote stations. On the left of the console from top to bottom are a digital readout on which the dispatcher can display any telemetered reading for close study, a digital indicator which is manually set when the dispatcher desires to change a set point, and ten action buttons for initiating control actions to the remote stations.

SERVO VALVE IN RAM CONTROLS

HIGH-SPEED HYDRAULIC PRESS

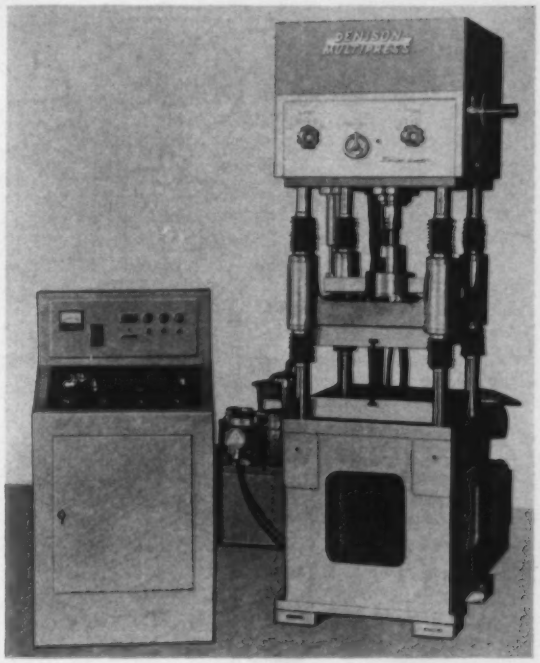


Fig. 1—High-speed hydraulic press is capable of operating at cycle speeds up to 600 strokes per minute. Major units include an electrical control console (left) a power unit (center background) and a four-column platen press (right). A servo valve built into the ram of the press provides control of ram speed, direction, and force.

BIGGEST DRAWBACK to wider use of hydraulic presses for operations such as metal stamping has been the relatively low cycling rates obtainable with this type of equipment. As a result, metalworkers have often been unable to take advantage of the desirable characteristics of hydraulic presses for these applications. Such characteristics include easy setup, ability to accommodate overloads, and controllable ram force, stroke, and speed.

A 25-ton hydraulic press developed by Denison Engineering Div., American Brake Shoe Co., *Fig.* 1, is a high-speed unit that retains the desirable characteristics of conventional hydraulic presses. Designed for applications such as blanking, drawing, and compacting, the press can attain cyclic rates as high as 600 spm when it is adjusted for a ¼-inch stroke. With a maximum 3-inch stroke, it can cycle at 50 spm.

Heart of the press is a power cylinder assembly that includes a ram with a built-in servo valve, *Fig.* 2. By means of associated mechanisms, electrical controls, and hydraulic circuits, the spool of the servo valve can be moved up and down in a preset path at controlled speeds. The ram automatically follows the motion of the spool and can exert maximum forces in accordance with flow and pressure conditions set up by valves. Details of the operation and control of the system are given in the box accompanying *Fig.* 2.

An interesting feature of the servo driven press is that ram forces during a work stroke are automatically adjusted to values that are just sufficient to overcome the resistance of the work. When the tooling first contacts the work, the ram may tend to be slowed. But the spool of the servo valve continues to move downward in the ram. The result is that the servo porting will change by an amount necessary to increase the ram force and maintain a selected speed. If the ram attempts to jump ahead as the work yields, the servo porting will become return porting and thus check the downward ram motion.

To ensure that sufficient pressure is available to operate the ram at maximum capacity, if needed, a dual pressure supply is provided. A low pressure pump supplies fluid to move the ram during most of the cycle and to operate a hydraulic motor and controls. When about 80 per cent of a downstroke has been completed, high pressure fluid from a second pump is fed to the power cylinder by a cam-controlled valve. This high pressure is maintained for the remainder of the downstroke and about 10 per cent of the succeeding upstroke. These percentages may be changed by replacing the control cam with one having a different shape.

Cycle speed and motion are controlled by a cluster of main cams on a camshaft driven by the hydraulic motor. As the camshaft revolves, a cam follower bearing on one of the main cams rises and falls. Through a linkage, the spool of the servo valve in the ram is lifted and lowered.

Any of seven main cams in the cluster may be selected to provide a stroke length of ¼, ½, ¾, 1, 1½, 2, or 3 inches. With a given main cam positioned beneath the cam follower, motion of the ram is harmonic. That is, ram speed increases to a maximum at mid-stroke and slows to zero at the ends of the strokes.

Other ram motions can be provided with special

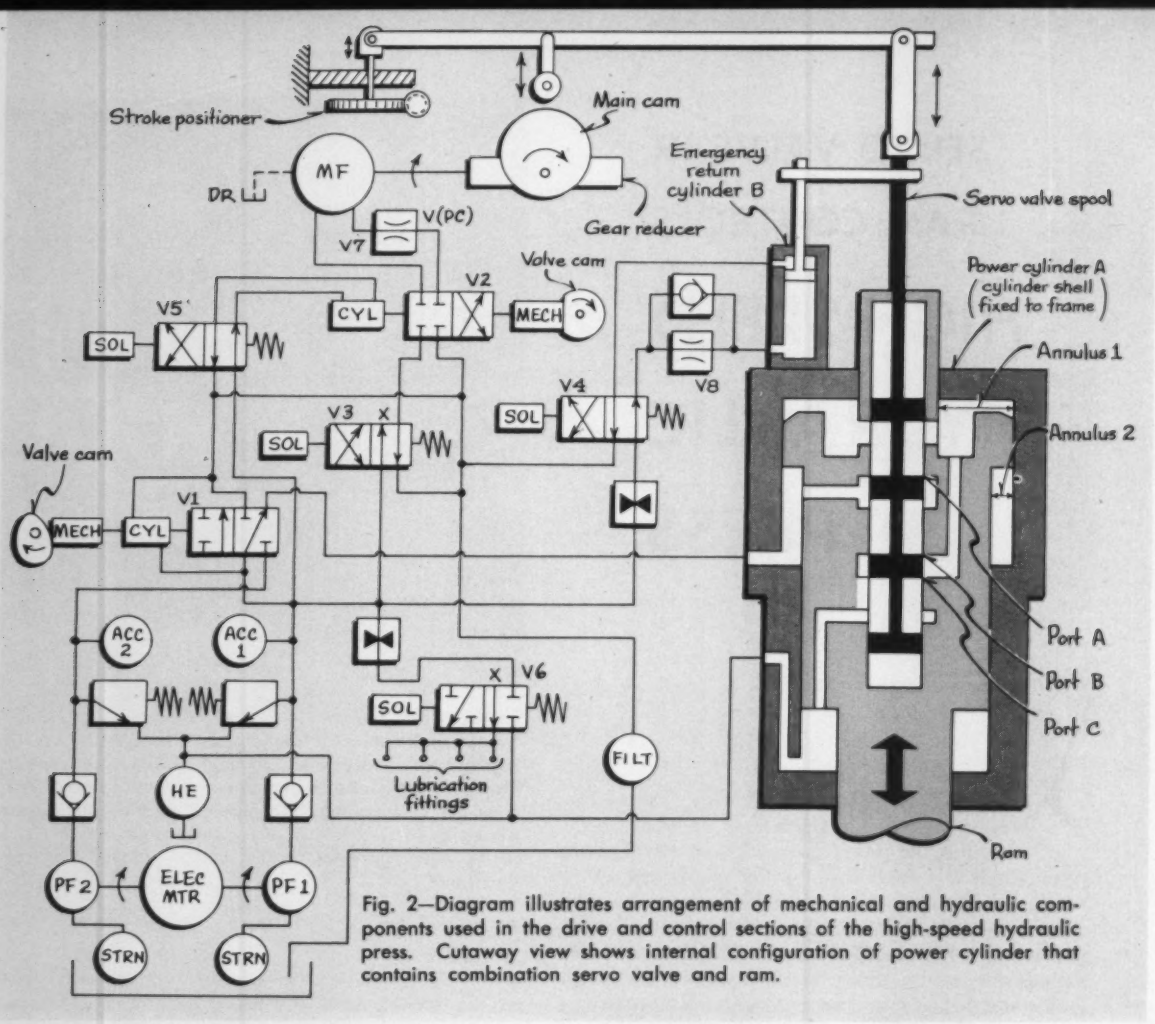


Fig. 2—Diagram illustrates arrangement of mechanical and hydraulic components used in the drive and control sections of the high-speed hydraulic press. Cutaway view shows internal configuration of power cylinder that contains combination servo valve and ram.

main cams. For example, dwell periods can be programmed at any point in a cycle. Thus, the ram can be held stationary at the top of its stroke while material is being fed. Also, cams with extremely short strokes can be used and the cycle speed increased. On simple blanking operations, $\frac{1}{8}$-inch strokes at 1200 spm are possible.

Safety protection to tooling is inherent in the press. Assuming that the ram cannot complete a downstroke, the ram and servo valve spool will be held up. When the main cam rotates sufficiently to again contact the cam follower, the spool and ram will be raised if the lifting force is sufficient. Otherwise, a safety spring mechanism on the linkage will allow the cam follower to rise without damaging machine components.

Units comprising the system include a four-column platen press, a hydraulic power unit, and an electrical control console which may be located remotely. Mechanical controls mounted on the front of the press provide adjustment of three variables: Ram speed, stroke, and bottom position. The camshaft that controls the timing and drive for the press extends out both sides of the unit. This feature permits adaptation of feed mechanisms to either or both sides of the press. The welded base of the unit has cutouts on all four vertical panels so that parts and scrap may be ejected in any direction.

Electrical controls on the console include push-buttons for *Pump Start* and *Stop*, *Cycle Start* and *Stop*, *Emergency Return*, and *Emergency Return Reset*. A rotary switch selects various operating conditions such as *Run*, *Inch*, *Inch Feed Only*, and *Off*. Speed indicating devices and counters may also be mounted on the console. With a predetermining counter, the machine may be stopped automatically when a preset number of pieces has been produced. Other control methods include continuous or intermittent operation of the press by external limit switches or other devices.

Reduction of cycle time and versatile ram setups are major features of the servo-driven press. Since press speed is an inverse function of the stroke, tooling should be designed for the shortest possible strokes. In this manner, the high-speed capabilities of the press can be exploited up to the point where feeder capabilities are exceeded or tool life is shortened.

HYDRAULIC AND ELECTRICAL CONTROL ACTIONS

STEPS in the operation and control of the high speed hydraulic press may be followed by reference to the simplified hydraulic and mechanical diagram of *Fig.* 2.

Startup Condition. Initially, the spool of the servo valve in the ram is lifted to its highest point by low pressure applied to the blind end of emergency return cylinder *B*. This low pressure (1000 psi) is supplied to cylinder *B* by pump *PF*1 through a check valve, an orifice, valve *V*4, and flow control valve *V*8. The rod end of cylinder *B* is connected to tank through *V*4 and a filter.

With the spool of the servo valve in its uppermost position, ports *A*, *B*, and *C* of the servo valve are closed. Low pressure is applied through valve *V*1 to the area of the ram designated Annulus 2. The ram is also in its highest position.

Begin Downstroke. To start the press, the solenoids for valves *V*3, *V*4, and *V*5 are energized causing the spools of the respective valves to shift. Shifting of the spool of *V*3 admits low pressure to the pressure port of valve *V*2 controlling fluid motor *MF*. The tank port of *V*2 is connected to tank through the filter.

Shifting of the spool of valve *V*4 opens a path so that low pressure fluid can flow through an orifice, then through *V*4, and act on the rod end of emergency return cylinder *B*. Simultaneously, a path is opened to connect the blind end of cylinder *B* to tank through valves and the filter.

When the emergency return cylinder is reversed by *V*4, the spool of the servo valve is lowered until a cam roller on a linkage contacts the high point of a main cam. The amount of this motion is dependent upon the particular cam selected. Different cams are available for press strokes of ¼, ½, ¾, 1, 1½, 2, and 3 inches. These cams are in a cluster and are positioned under the cam follower by a selector mechanism that slides the cams along a camshaft.

Shifting of the spool of valve *V*5 operates a control cylinder on valve *V*2 causing the spool of this valve to shift. This admits low pressure from valve *V*3 to one port of motor *MF* through flow control valve *V*7. It also connects the other port of motor *MF* to tank through the filter. Motor *MF* then rotates the camshaft through a gear reducer.

Rotation of the camshaft causes the cam follower to move up and down in accordance with the shape of the main cam that has been selected. This motion is reflected in up and down motion of the spool of the servo valve in the ram, since the valve spool and the cam follower are connected by a linkage. At this time, the downward force exerted on the linkage by the emergency return cylinder holds the cam follower against the main cam and eliminates backlash.

As the main cam rotates on a down stroke, the spool of the servo valve moves downward opening ports *A* and *B*. Port *C* remains closed. The effect is to admit low pressure to the top of the ram and cause this member to stroke downward. The effective ram area is that of Annulus 1 minus Annulus 2.

Complete Downstroke. Due to the harmonic motion characteristic of the main cam, the ram moves slowly at the beginning of a downstroke, picks up speed to a maximum at the middle of the downstroke, and then slows down again as it approaches the end of the downstroke.

When the ram has completed 80 per cent of a selected downstroke, a cam on the cam shaft shifts the spool of valve *V*1, overcoming the force exerted by a control cylinder on the valve. The effect of this action is to block the flow of low pressure fluid to the power cylinder and admit high pressure fluid (3700 psi) to this cylinder. The higher pressure provides greater ram force during the working stroke.

Return Ram. The ram begins its return motion when the cam follower is lifted by the main cam. The resulting upward motion of the spool of the servo valve closes ports *A* and *B* and opens port *C* of the valve. Thus, a path is opened to exhaust the fluid acting on top of the ram. High pressure applied to the area designated Annulus 2 causes rapid return motion of the ram.

When about 10 per cent of the return stroke has been completed, the cam associated with valve *V*1 allows the cylinder control to shift the valve. This action cuts off the high pressure and applies low pressure to the power cylinder for the remainder of the ram return stroke.

Special Provisions. Emergency return of the ram can be effected at any point in a cycle by operation of an *Emergency Return* pushbutton on a control console associated with the press. This action de-energizes the solenoid of valve *V*4 causing emergency return cylinder *B* to lift the spool of the servo valve to its highest position. The ram automatically follows the spool because of the valve port configurations that result from lifting of the spool.

Operation of the *Emergency Reverse* pushbutton also de-energizes the solenoid of valve *V*3, stopping the flow of fluid to valve *V*2 and motor *MF*. Thus, the camshaft stops immediately. The effect is to interrupt the feed at the same time that the ram returns. These safety features are useful in the event of jammed tooling or feeding devices.

Another function of valve *V*3 is to permit inching the tooling and feed to any position for setup or other purposes. With the ram held in its uppermost position by *V*4, the feed alone can be inched by *V*3 with the tooling wide open.

The solenoid of valve *V*6 is energized periodically by a timer. When the spool of this valve shifts, low pressure fluid is allowed to flow through an orifice to a series of lubrication valves. Each lubrication valve then passes a measured quantity of hydraulic oil to a lubrication point on the machine.

Flow control valve *V*7 which controls the speed of motor *MF* (and thus the number of cycles per minute) is interlocked with the stroke selector mechanism. When a main cam for a particular stroke is positioned under the cam follower, the maximum speed setting of the flow control valve is automatically limited to provide a safe maximum motor speed for that cam.

The cam cluster designed to permit changing strokes is made so that the shut-height, or bottom ram position, is identical for all strokes. A stroke positioner at the end of the linkage connecting the cam follower and the servo valve spool permits fine adjustment of the bottom ram position. By means of a worm and screw arrangement, the pivot point for the linkage can be raised and lowered through a range providing a total adjustment of 0.500 inch in the ram bottom position.

A mechanical arrangement associated with valve *V*2 ensures that the press will stop with the ram in its top stroke position when a *Cycle Stop* pushbutton is depressed. The device includes a cam driven by the camshaft that prevents shifting of the spool of valve *V*2 in a direction to stop the motor unless the ram is in its highest stroke position.

To keep pump volume and horsepower requirements to a minimum, accumulators *ACC*1 and *ACC*2 have been provided for the low and high pressure circuits. The function of the accumulators is to store pumped oil when the system demand is less than the available supply, and to supply oil when demands are greater than pump capacities.

Since the speed of the ram varies during a press cycle, the accumulator in the power cylinder circuit at a given time stores oil in low-speed periods and returns the oil to the circuit during high-speed ram movement periods. When the low pressure circuit is supplying the power cylinder, accumulator *ACC*2 is charged to the high-pressure setting of the relief valve for *PF*2. With high pressure applied to the power cylinder, excess volume provided by low pressure pump *PF*1 is stored in *ACC*1.

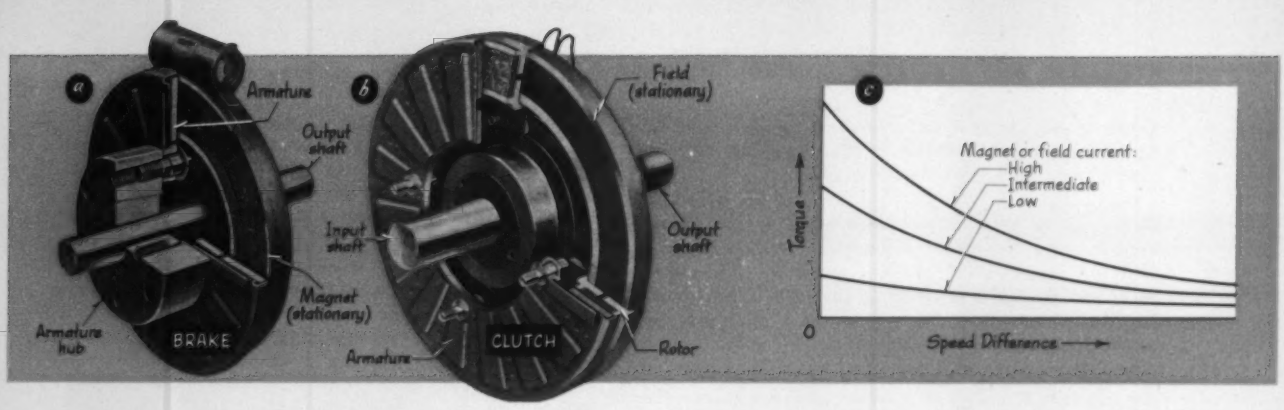


Fig. 1—Electric brake *(a)* and electric clutch *(b)* are typical units used in a variety of applications for controlling tension in webs fed from unwind reels. Torque-speed characteristic curves, *(c)*, apply to both brakes and clutches. The amount of torque that either unit can develop depends upon both the magnet current and the speed difference between the friction surfaces. Zero speed difference exists when a brake load is completely stopped or when a clutch output shaft is up to input shaft speed. Control is effected by regulating the magnet current to produce a required torque at a given speed.

CONTROLLING UNWIND REELS

WITH ELECTRIC BRAKES AND CLUTCHES

By **HAROLD A. OLSON,** Warner Electric Brake & Clutch Co., Beloit, Wis.

THERE ARE three common methods of controlling tension in coil stock being fed from unwind reels to machines such as punch presses, slitters, and tube welders. These methods are: 1. Use of a variable speed drive for the unwind reel. 2. Use of an electric brake to provide controlled drag and stopping forces for the reel. 3. Use of a constant speed motor-electric clutch arrangement to drive the reel and an electric brake to apply drag or stopping forces when the clutch is disengaged.

In its line of unwind reels with coil capacities from 100 to 40,000 pounds, F. J. Littell Machine Co. uses all three methods. For example, variable speed drives are used on reels designed for high speeds, for feeding of coils weighing over 10,000 pounds, or where precise tolerances on payoff speed and web tension must be maintained.

For a large number of applications, however, the company has found that unwind reels equipped with electric brakes, or electric clutches and brakes, are entirely satisfactory. A reel equipped with a brake can be used where coil stock is drawn from the reel by another machine. Where the unwind reel is to be driven, a motor-clutch arrangement can be used and retarding force can be supplied by a brake.

The components used are electromagnetically actuated, friction-disc type units manufactured by Warner Electric Brake & Clutch Co. A typical brake is illustrated in *Fig.* 1*a* and a clutch is shown in *Fig.* 1*b*. Torque-speed characteristics for either a brake or a clutch are indicated by the curves of *Fig.* 1c.

Brake Control

When a web is drawn at a uniform rate from a braked unwind reel, the web tension in pounds is a function of the ratio of drag torque in pound-feet to the outside radius of the coil in feet. As material is fed from the coil, the coil radius decreases and the spindle speed increases. To maintain constant web tension, therefore, a brake should provide proportionally less drag with decreasing coil radius and increasing spindle speed. This torque-speed characteristic is approximated in the curves of *Fig.* 1c where, for a given magnet current, torque is reduced as the speed difference increases. In many instances, one value of magnet current will hold web tension

within allowable limits for an entire coil. An unwind reel controlled by an electric brake is shown in *Fig.* 2.

In a typical brake control circuit, *Fig.* 3*a*, a *Drag* rheostat may be adjusted to provide different amounts of dc current flow in the brake magnet. Thus, the brake torque, or drag, may be adjusted to suit the operating conditions. For example, a relatively low dc current may be selected where dead soft stock is handled, and a relatively high dc current may be used to provide more drag on springy materials that tend to uncoil easily.

The brake control circuit may be interlocked with other units in the line so that maximum magnet current and brake torque will be applied automatically when the line is stopped. This is accomplished when a *Stop* switch, *Fig.* 3*a*, is operated to short-circuit the rheostat and permit maximum current flow in the magnet. The *Stop* switch can also be operated manually, or it can be actuated by a dancer arm riding on the loop formed in the web between the unwind reel and the other units. With the latter arrangement, full braking effort can be applied to the reel whenever the amount of stock payoff causes excess slack in the loop.

If a value of shutdown brake torque less than maximum is desired, a *Brake* rheostat may be added to the circuit as in *Fig.* 3*b*. With this circuit, maximum operating drag is limited to the amount of braking effort selected on the *Brake* rheostat for stopping the reel.

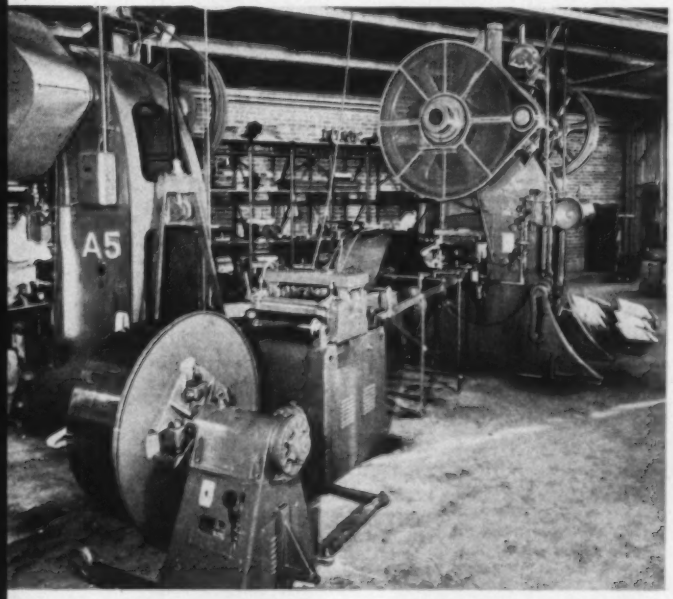


Fig. 2—An electric brake is used on an unwind reel (left foreground) which is part of a press line at General Machine Works. In operation of the line, stock is pulled from the 2500-pound capacity reel by a straightener. From the straightener, the material is fed to the press. Function of the brake is to prevent overrunning or premature unwinding of the coil on the unwind reel. Brake drag is adjustable by means of a rheostat on the reel pedestal.

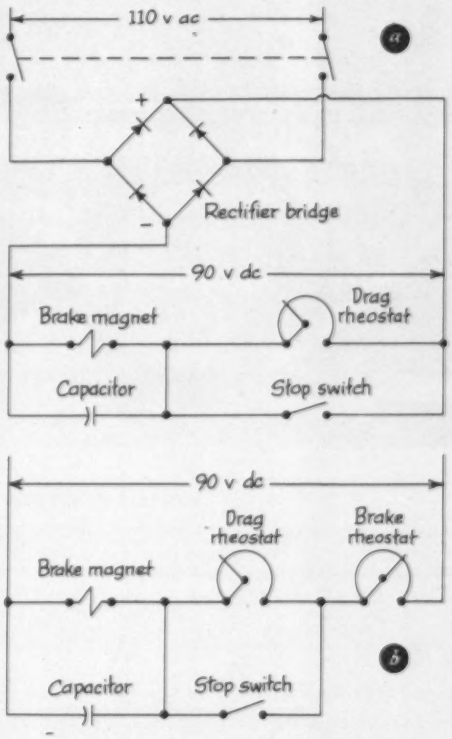


Fig. 3—Control circuit for an electric drag brake operates from 110v ac power line. Rheostat setting determines tension or drag, and *Stop* switch produces maximum braking action for shutdown, *(a)*. Alternate control circuit, *(b)*, uses an additional rheostat to limit maximum operating and shutdown torque.

▶ Clutch and Brake Control

Motor-driven unwind reels, *Fig.* 4, use both a clutch and a brake. The function of the clutch is to permit continuous operation of the drive motor and thus relieve the motor and its starter of the strain of frequent starting and stopping. The clutch is engaged only when stock is required by the process. The brake is energized to apply drag whenever the clutch is disengaged.

An automatic control circuit for a motor-driven unwind reel is shown in *Fig.* 5. In the circuit, a *Loop* switch alternately energizes the clutch and brake to keep pace with stock demand. The clutch and brake have separate rheostats so that their operating characteristics can be adjusted individually. Thus, the clutch can be set to deliver a relatively high torque required to accelerate a loaded spindle, and the brake can be set to provide a lower torque needed for dragging.

The *Loop* switch can be actuated by a dancer

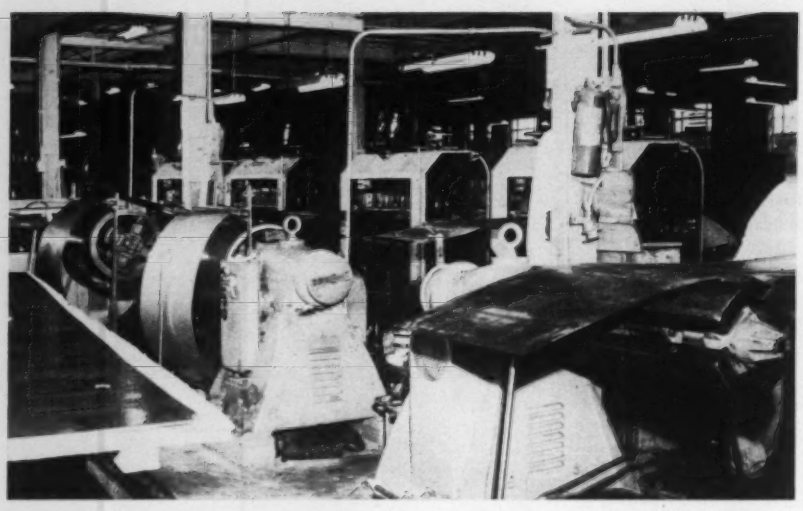


Fig. 4—Motor-driven unwind reels in these parallel processing lines can feed steel coils weighing up to 10,000 pounds. For each reel, the motor runs continuously. A clutch is engaged to drive the reel when a loop control switch calls for more stock. When the clutch is disengaged, a brake is automatically energized to apply drag.

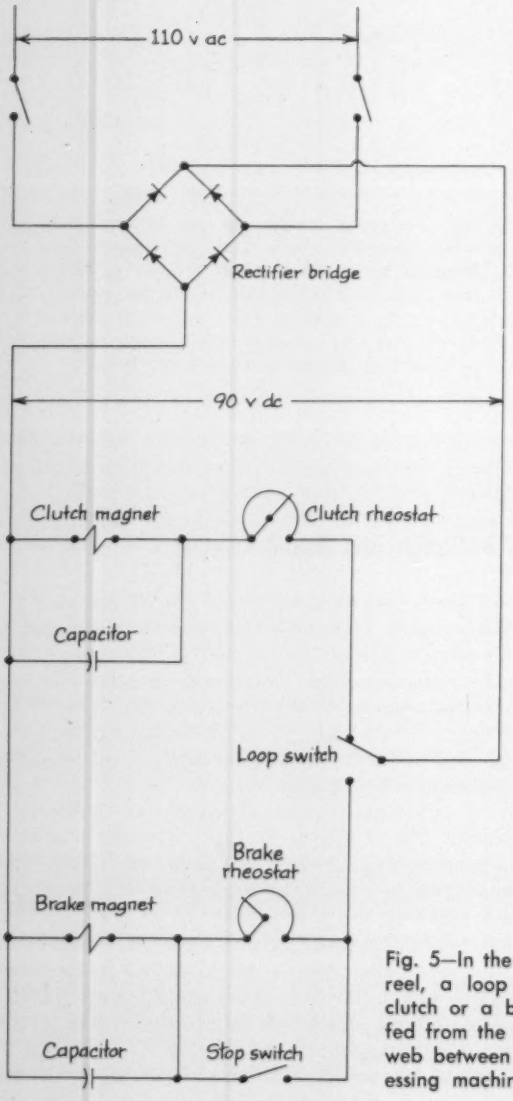
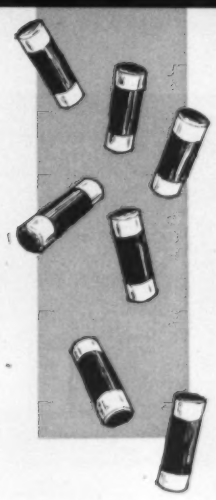


Fig. 5—In the control circuit for a motor-driven unwind reel, a loop switch alternately energizes an electric clutch or a brake to feed or retard coil stock being fed from the reel. The loop switch is actuated by the web between the unwind reel and a subsequent processing machine.

arm riding on the loop or by a paddle that senses the presence of a free, outer coil turn at the base of the unwind reel. Photoelectric sensing devices may be substituted for a mechanical switch. All three control means operate on the same principle, namely, to disengage the clutch and apply the brake whenever the loop sags because too much stock has been fed and to reverse the procedure when the loop tightens, signifying a need for more stock to be fed.

In addition to control of demand feeding, a loop control system can be used to regulate tension in a web. By careful adjustment of the points at which clutch *On* and *Off* actions are initiated by the *Loop* switch, it is possible to maintain web tension within plus or minus 5 per cent in continuous operations.

At one time, Littell motor-driven unwind reels were operated without clutches. Instead, the drive motors were started and stopped to keep pace with stock demands. However, this led to overheated motors when more than 10 to 12 starts per minute were required with open type motors. For enclosed motors, even fewer starts were possible due to overheating. With clutch-controlled operation, loaded spindles can be accelerated as many as 50 times per minute without overtaxing the drive. At the same time, a smaller motor can be used for a given reel. With the motor always up to speed, its pull-out torque (which is significantly higher than its starting torque) is available to accelerate the load whenever the clutch is engaged.



TESTING AND SORTING RESISTOR BLANKS

Testing and sorting operations for discrete parts are fertile fields for the application of automatic techniques. The automatic machine described by the authors uses a unique pneumatic feeding technique to orient and store carbon resistor blanks for subsequent resistance testing and sorting.

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VARIOUS products have been sorted automatically at the Hawthorne Works, Western Electric Co. Inc., for over a quarter of a century. Devising ways and means to do this faster, more economically, and at a continued high degree of reliability poses a constant challenge to the product engineer. Among the more recent automatic sorting devices developed is a high speed sorting machine for carbon resistor blanks which uses a pneumatic feed system. This machine, which sorts three blanks per second, was developed as part of a program for providing production facilities to manufacture and inspect deposited carbon resistors as a result of an increase in requirements.

Based on an article published in *The Western Electric Engineer*, Vol. 5, No. 1, January 1961.

There were numerous ways to approach the problem of providing appropriate facilities, two of which were either the complete tandemization of the product line or the use of individual high speed units. The latter alternative was chosen as being economically suited for the operation.

The Process

Our process of making deposited carbon resistors, which is similar to others throughout industry, starts with the coating of cylindrical ceramic rods with pyrolytic carbon. The thickness of the carbon coating varies with the resistance desired. Heavily coated parts provide resistors that go below one ohm per

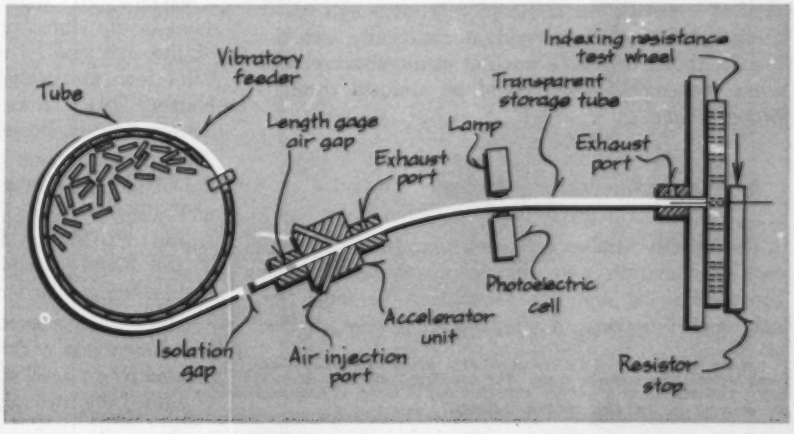


Fig. 1—Plan view of the pneumatic feed system for the carbon resistor sorting machine is shown. A vibratory feeder orients and feeds the cylindrical blanks across the isolation gap and into the length gage. A pressure differential, created by the air injection ports, draws the blanks into the accelerator unit. The blanks are then blown into the storage tube from which they are fed into the indexing resistance test wheel. The photoelectric unit stops the machine if the storage tube is not full.

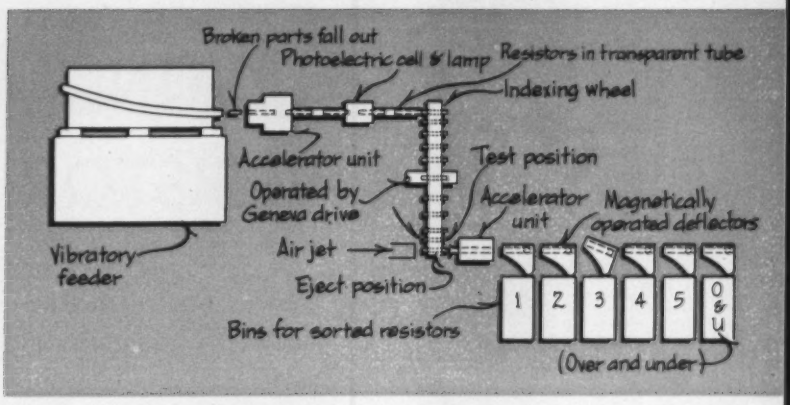


Fig. 2—Elevation view of the machine shows the indexing wheel, test position, and sorting mechanism. As the blanks are rotated by the wheel, they are contacted by wiper terminals in the test position. In about one-sixth of a second, a dc Wheatstone bridge network with relay switching determines the resistance category for the blank under test. This information is entered into a relay memory circuit until the blank has indexed to the eject position. At this time, an air blast blows the blank into an accelerator unit which propels the blank through the deflectors until it contacts one that has been raised by the memory circuit.

square, whereas lightly coated parts range up to approximately 6000 ohms per square.*

After coating, the ends of the carbon-coated rods are covered with bands of silver paint, and in this state the rods are referred to as blanks. Since resistors are coated in batches of several thousand, the relatively broad spread of resistance values in a batch requires the sorting of the blanks into groups of resistance values. These groups are established on a five per cent increment basis from a fixed starting value. After sorting, metallic caps and leads are attached. To get high values of resistance, a spiral cut or helix is made through the carbon. By this means resistance values up to several megohms can be obtained.

It has been the practice to adjust helixed or unhelixed resistors by rubbing off some of the carbon while the part is being tested. This rubbing-off process raises the resistance to the required value. However, with precision sorting into five per cent cells and some sorting into one per cent cells, much of this adjusting procedure can be eliminated.

Up to the present time, most of the resistors have been sorted by hand, a special ohmmeter being used to determine the proper cell. The hand sorting had been at the rate of about 1200 blanks per hour. The goal for automatic sorting was arbitrarily set at 10,000 blanks per hour.

Originally it was felt that a commercial machine might be adapted for the operation. However, subsequent investigation disclosed that, although many commercial machines would automatically sort the blanks, the hourly rate was not commensurate with what the engineers felt could be attained through proper design.

▶ Pneumatic Feeding System

Preliminary studies indicated that simplicity and ease of operation were the prime requirements for the mechanical design of a sorter. The feed, test, and sort functions of the machine were divided into separate stations. Information gained at the test station was to be stored in a memory device until the blank was transferred to the sorting station.

The initial problem concerned feeding the blanks to the test station. Consideration had to be given to a loading station which would hold the blanks prior to entry into a transfer device. Because of the size of the blanks and the large quantities required per hour, a vibratory feeder was chosen due to its capacity to feed the blanks at a rapid rate as well as properly orienting the blanks for entry into the feed section.

In considering the proper design to be used in feeding the blanks, it was recognized that mechanical feeding devices do not inherently lend themselves to high transfer speeds, and the heart of the sorting device would be the feed section. The cylindrical configuration of the blank as well as its relatively low weight suggested that a pneumatic system would afford the necessary transfer speeds. The system which finally evolved is shown in *Fig.* 1.

As the blanks proceed from the vibratory feeder across an isolation gap, they are received by a tapered bushing insert prior to entering the air gage. The isolation gap has a dual function. The space eliminates any possibility of transmitting the vibrations from the feeder to the rest of the system and also permits chips and miscellaneous debris to fall out, thereby preventing contamination to the system. The tapered bushing accommodates blanks which have a tendency to "wobble" as a result of their movement in the vibratory feeder. Approximately $\frac{1}{4}$ inch of the exit end of the bushing is straight, being 0.011 inch larger than the nominal diameter of the blanks. This enables a blank to enter an air gage in a relatively horizontal position as it feeds out. The adjustable air gap for gaging the length of the blanks is nothing more than an air space which will allow broken or occasional undersize blanks to fall out. Proper disposition of the various codes of the blanks precludes the possibility of oversize blanks being mixed prior to the sort operation.

After passing over the length gage, the blanks are drawn into a storage tube by the venturi effect created by an accelerator unit. A pressure differential is caused by two air injection ports, positioned at

*"Ohms per square" is the resistance of a square film when measured between two opposite edges. The size of the square is immaterial. This method of specifying film thickness in terms of resistance is common in the film resistor industry.

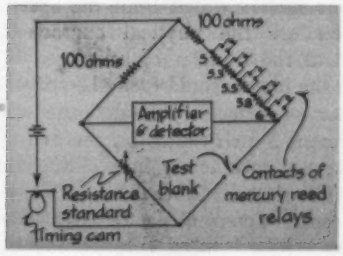
an angle to the desired direction of parts flow, in the accelerator unit. Regulators vary the injection pressure depending on the code of the blank being sorted. Pressures used vary from as low as 3 psi on the smaller blanks to 12 psi for the larger codes. Filters were also installed in the air line to prevent any contaminants from entering the air system and possibly altering the resistance values of the blanks.

Regulation of the exhaust ports controls back pressure (which aids in gaging the blanks for length), provides a full storage tube, and insures smooth flow. The slotted bushings which constitute the exhaust ports are changed when the air pressure in the accelerator unit is varied for different blank sizes. A photoelectric cell acts as a safety device to prevent any misfeeds at an index wheel. This unit stops the wheel if the storage tube is not full. The blanks are advanced into the index wheel by the pushing action of the other blanks.

The index unit is a nonconducting methyl methacrylate plastic disc with a series of equidistant holes and a front and rear guide. The rear guide of the wheel is furnished by the housing of a Geneva drive unit while the front guide is of plastic. A set of spring-loaded wiper terminals is located on each side of the index wheel just one step ahead of the discharge position. Thus, the blanks are fed into the index wheel at the top, carried around to the bottom, and tested. The test information is then stored in a memory device which activates deflector units after the blanks are discharged.

▶ Sorting System

The distribution of resistors into cells is accomplished by means of a series of deflector units shown in *Fig.* 2. Since the distribution is done along a horizontal path, controlled impetus is afforded the blank so that the timing of the sorting arrangement remains constant. The blank impetus is provided



RESISTANCE TESTING

RESISTOR blanks are automatically tested by means of a dc Wheatstone bridge network as shown above. Specially calibrated resistors are connected in series with one of the ratio arms of the bridge. Each resistor is normally shorted by the contacts of a high-speed mercury reed relay. These reed relays are operated by fast wire spring relays in a chain circuit. As each mercury relay operates, it adds five per cent incrementally to the resistance of its associated ratio arm. This chain operation, with the five increments of resistance, can be accomplished in less than one-tenth of a second. The second arm of the bridge contains the resistor under test. The third arm contains a resistance standard which is set to the lowest value of the particular group of sorting cells being used. The resistance standard is a five-decade resistance box adjustable in 0.1 ohm steps to 10,000 ohms.

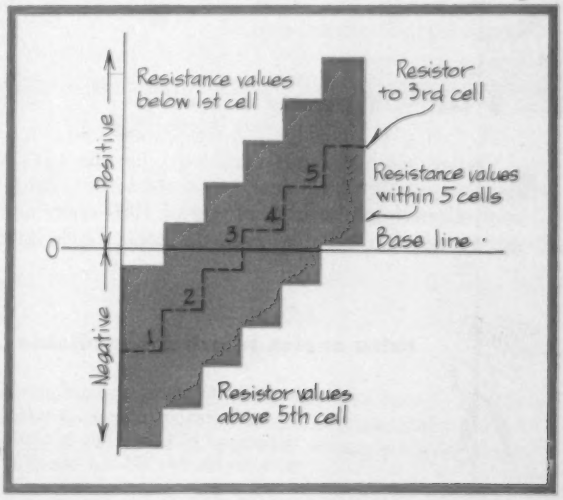
The detector corners of the bridge are connected to a high-gain 400-cycle chopper-type dc amplifier. A diode circuit in the input to the amplifier limits the negative unbalance signal to a value within the capabilities of the amplifier.

As the mercury relays operate and the bridge goes through balance, the bridge output is in the form of voltage steps, right Chart. When all steps are negative, the resistor is above the sorting range. When all the steps are positive, the resistor is below the sorting range. When the resistor is within the sorting range, one of the five steps crosses the zero line (goes from negative to positive). This positive signal after amplification is connected to the grid of a thyratron. The firing of the thyratron drops the operating voltage of the chain of relays from 48 volts to about 10 volts in a few microseconds, thereby preventing further operation of the chain. The relay in the plate circuit of the thyratron closes a circuit through the operated contacts of the relay chain to operate one of two memory circuits.

The purpose of each memory circuit is to store the test information until the resistor is indexed to the eject position. Each memory circuit consists of five plug-in relays and an associated timing cam.

The actual time that the resistor is stationary in the testing position is about one-sixth of a second. During this time, the bridge circuit is closed by the cam-operated switch, resistance checks made, memory circuit energized, and the bridge circuit opened.

Reset-type counters are provided for each cell as well as one for the *Over* and *Under* resistors. By means of these counters, the resistance distribution of any lot of resistors can be quickly and accurately determined.



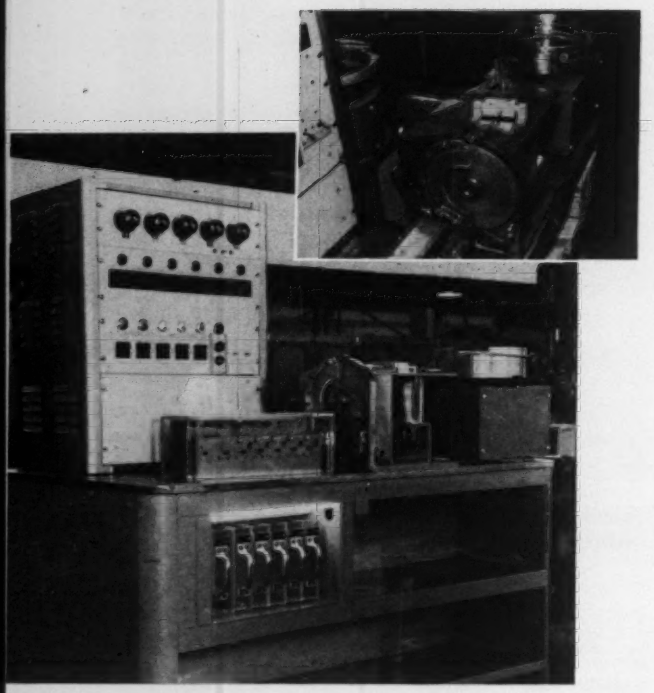


Fig. 3—One of the two sorting machines that have been built is shown. Output of each machine at 100 per cent efficiency is approximately 10,800 resistors per hour. Inset shows a top view of the pneumatic feeding system.

by an accelerator unit similar to that used in the feed section of the machine. A continuous air stream, located at the back side of the eject position, starts the blank out of the index wheel and into the acceleration unit which then moves the blank at the desired speed through a deflector assembly into the proper bin. The deflector units are made of tungsten carbide to resist the abrading effect of the resistors as they are diverted from the horizontal path into their proper bins. To reduce damage to the blanks in the bins, each bin incorporates a baffle box constructed with Teflon inserts.

Proper timing of all electrical circuits and the deflector units is maintained by a set of cams driven by a Geneva unit. The electrical circuit would have to be fast enough so that the entire sorting operation would be completed in 1/3 second. Based on this premise, this would allow approximately 1/6 second for the electrical tests.

Testing System

Various methods were considered for the test. A resistance-capacitance time constant method, while very effective in the high ranges of 1000 ohms and up, is not too reliable over the total range and was dropped from further consideration. A mercury jet switch in a bridge circuit and an ac bridge using a variable air-capacitor method were considered because of their high speed and low contact resistance. But since the blanks were to be diverted into only five cells, the high speed was not essential. Because of the high accuracy afforded by the system, a dc Wheatstone bridge with relay switching was finally decided upon as the best electrical test for the given situation. An explanation of the testing system is outlined in the box entitled "Resistance Testing."

The existing test circuit and sorting system could test and advance the blanks at double the present rate. The factors which limit the speed of this sort operation are the physical characteristics of the blank and the number of cells used in sorting. In sorting, the blanks could easily be chipped or cracked if the curved surfaces of the deflector were too sharp. The present 3-inch radius on the deflector unit had to be proved satisfactory in avoiding damage to the blank. The six cells into which the blanks are sorted is the other deterrent factor. Before a succeeding blank can be advanced through the deflectors, the preceding blank has to clear the deflector units. Accordingly, the sort interval in this application is the time required for a blank to travel to the farthest deflector. For example, the maximum time required for a three-cell separation is one-half the time required for a six-cell sort operation.

Two sorting machines, *Fig.* 3, have been in shop use for some time, and each has been sorting at the rate of about 10,800 resistors per hour. The discrimination between cells is of the order of plus or minus 0.2 per cent or better. A set of standard sorting values has been set up in five per cent steps so that a bank of resistors is available either for immediate use, for adjusting to a closer tolerance, or for helixing to a higher value. The new sorting machine is also capable of taking a five per cent cell and sorting it into 5 one per cent cells.

With the advent of high production miniaturization, pneumatic feeding can in many instances provide the reliability and the speeds necessary to economically transfer minute parts to operating positions. Pneumatics, however, are not a cure-all for all situations. Fragility, weight, configuration, and size of the part to be transferred should be considered before suitability of the system is established.

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ELECTROSTATIC PAINTING SYSTEM ADAPTS TO PART SIZES

RECENTLY modernized refrigerator painting line exemplifies the trend towards production equipment that is both automatic and versatile. Kelvinator, a division of American Motors, produces four basic models of refrigerators, with the largest size differing from the smallest by as much as 2 feet in one dimension. As a production improvement the company has installed a Ransburg Electro-Coating Corp. automatic electrostatic painting system that can accommodate itself to mixed sizes of refrigerator cabinets and doors interspersed along a conveyor line.

Following fabrication and a six-stage cleaning process (clean, hot rinse, cold rinse, Bonderite, cold rinse, and de-ionized rinse), work is transferred from an overhead conveyor to a 1260-foot floor conveyor leading into a pressurized painting room. Operating at speeds from 12 to 24 fpm, the conveyor handles mixed sizes of cabinet shells (to be painted on four surfaces) and doors (to be painted only on one surface). Doors are mounted two to a fixture for conveying through the system.

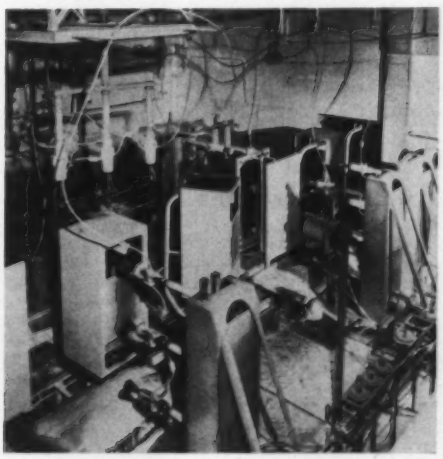
Essentially, four electrostatic painting stations are located within the painting room. At the first station, the sides of cabinets and the surface of doors receive an initial coat of paint from four reciprocating electrostatic units, two on each side of the conveyor line. Each reciprocating unit includes three atomizing "bells" mounted one above the other in a vertical arrangement. The atomizing bells, rotating at 900 rpm, move up and down in short strokes to apply a uniform 1.8 to 1.9 mils coating on parts.

As different-sized parts are moved in front of the painting units at a station, limit-switches are actuated to position the bells at the proper painting distance from the work. The spray of paint is activated by separate photoelectric systems located ahead of each of the four painting stations.

Following painting at the first station, refrigerator doors by-pass the second and third stations, proceeding to the fourth station for a final coat. A mechanical arrangement indexes refrigerator cabinet shells between the first and second station so as to present the rear cabinet surfaces to a single, three-bell reciprocating paint unit located along the conveyor line. Simultaneously with the painting of the back of the cabinets at this second station, a stationary three-bell unit mounted overhead applies the first coating to the cabinet tops.

After a short flash-off, cabinets pass through the third station where cabinet tops receive a second coating, again from a stationary overhead unit. Between the third and fourth stations, cabinets are indexed back into their original orientation. At the fourth station the sides receive a second coating from an arrangement of reciprocating painting units identical to that at the first station.

Automatic painting is augmented, where necessary, by additional manually operated spray units both before and after entering the enclosed painting area. Finished painted cabinets and doors move into a gas-fired, overhead oven and bake out at 305F for 30 minutes. After baking, the parts are transferred to an overhead storage conveyor that serves the assembly operation.



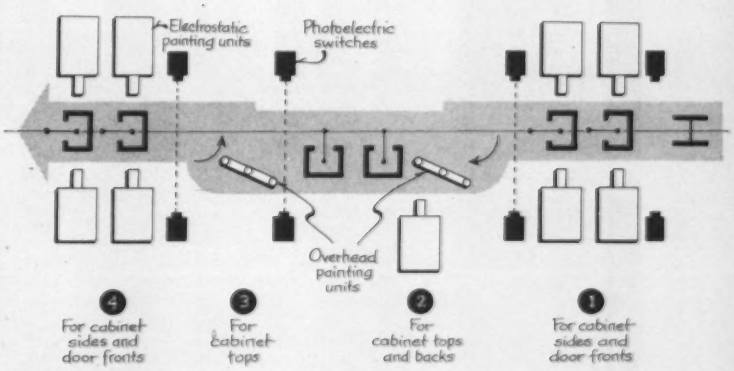
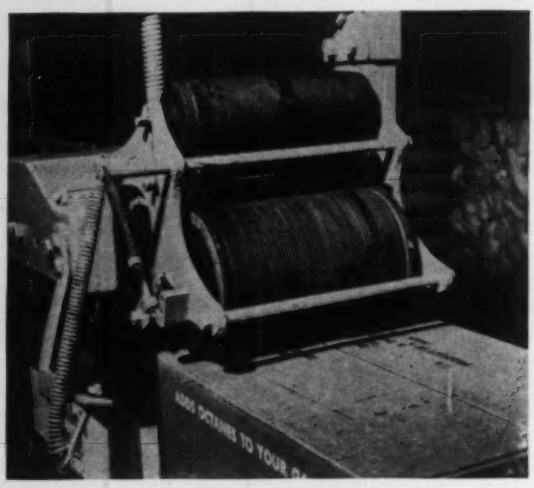
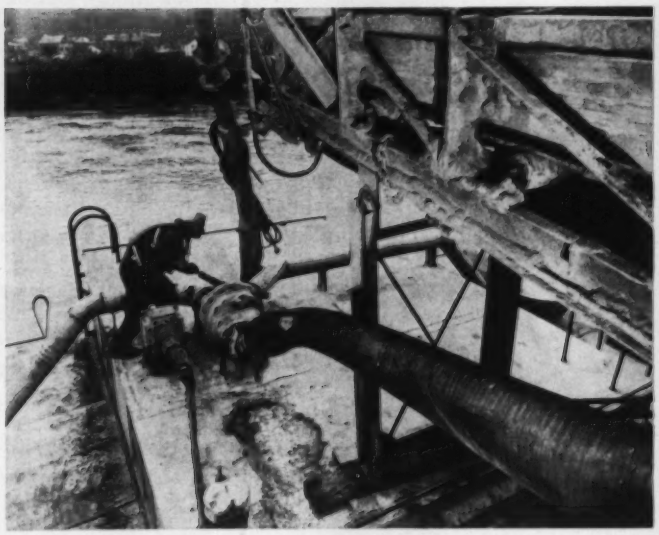


Diagram illustrates arrangement of electrostatic painting units that can handle mixed sizes of refrigerator cabinet shells and doors. Limit-switches control position of atomizing bells relative to surface of the various parts to be painted. Photoelectric switches activate painting cycle for each station.



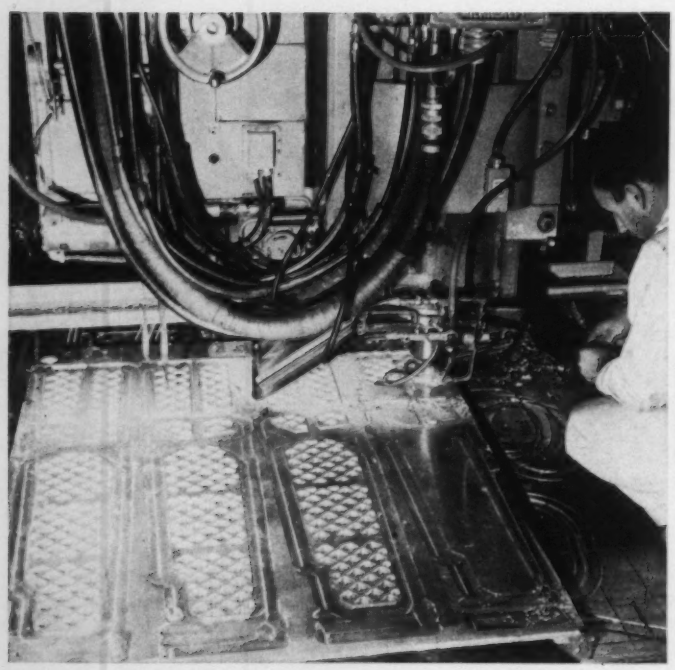
Marking Cartons

AUTOMATIC printer at Brooklyn Refinery of Mobil Oil Co. marks 850 sealed cartons per hour as they move on a conveyor from packaging machinery. Friction between a moving carton and the printer's marking head starts the marking cycle. Industrial Marking Equipment Co. Inc. supplied the printer.



Loading Cement Barges

BARGE dock of Green Bag Cement Co. transfers cement from storage silos to barges at a rate of 600 barrels per hour. Vital link in the pressurized handling system is the flexible hose in foreground which is used because the barges sink lower in the water as they are loaded. B. F. Goodrich Industrial Products Co. supplied the special rubber hose that handles the limestone, granulated slag, and silica sand down to the barges under 30 psi pressure and at temperatures up to 200 F.



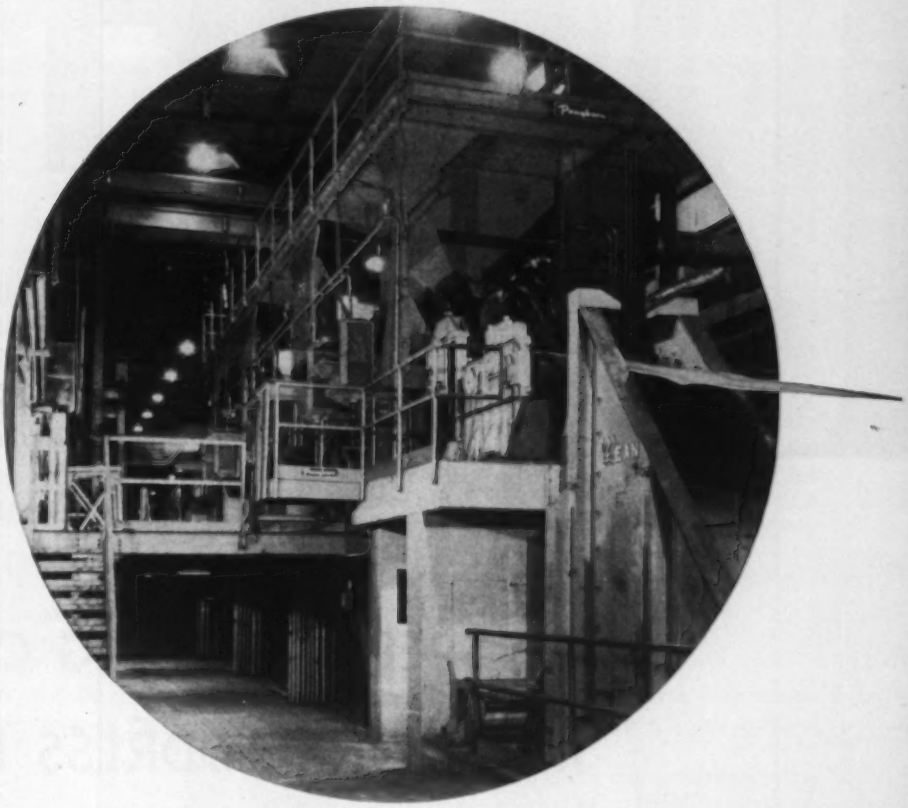
Milling Intricate Patterns

NUMERICAL control of a dual cutter Kearney and Trecker mill produces intricate waffle patterns in sheet magnesium skins for Bomarc missiles. This operation had previously been performed by chemical milling, but Boeing Airplane Co. developed procedures for machining the parts on the magnetic tape controlled skin mill at a saving of $283 per missile.

in action

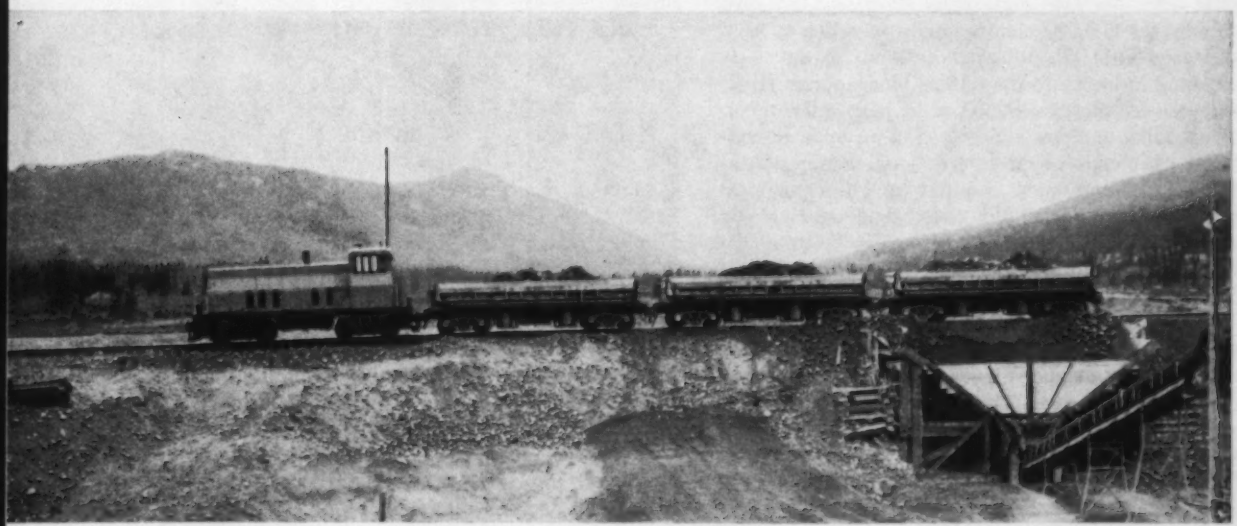
Descaling Steel Strip

LARGEST blast descaling machine in the world can simultaneously process both sides of continuous steel strip 24 to 50 inches wide at rate of 120 tons per hour. Twelve blast wheels hurl 660 tons of abrasive per hour to prepare hot-rolled carbon and silicon strip for cold rolling. Groups of four blast wheels are mounted in separate cabinets with two elevators, two air-wash separators, and a storage bin. Replenishment of the abrasive supply in each bin is controlled automatically by a bin level sensing system. Blast wheels are adjustable for optimum coverage of various strip widths and may be removed for maintenance without stopping the machine or having a man enter a cabinet. Pangborn Corp. designed and built the installation for Empire-Reeves Steel Corp.



Remote Controlled Train

DIESEL locomotive and the dump body cars it pulls are controlled from a remote control tower at the gravel processing plant of the Quebec, North Shore & Labrador Railway. The cars are loaded with raw gravel by a power shovel whose operator is in radio communication with the control tower to direct spotting of cars for loading. A man in the control tower controls the equipment to process the gravel and the movements of the train to carry the raw gravel about a mile from the loading point to the feed hopper of the gravel plant. Signals transmitted from a line strung on poles along the track control train movement and automatic dumping of the cars. General Railway Signal Co. supplied the remote control system.



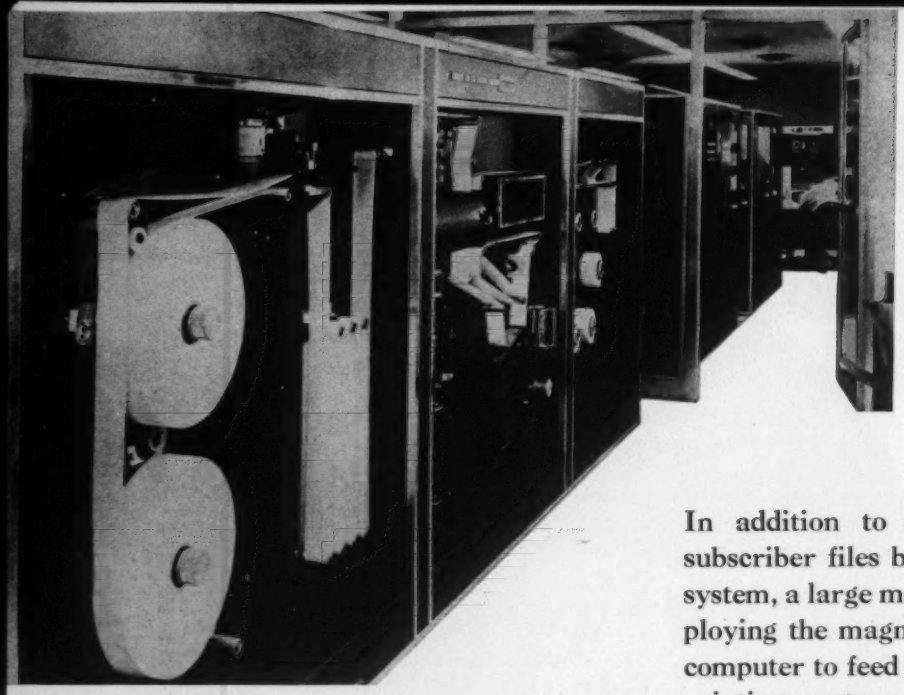


Fig. 1—General view of one of the two label printing systems is shown. In the foreground is the three-section label printer which is capable of preparing over 130,000 labels per hour. Further down the aisle on the left can be seen the tape reader and buffer unit for the printer. At the extreme end of the aisle is an IBM computer which maintains subscriber data.

In addition to maintaining up-to-date subscriber files by means of a computer system, a large magazine publisher is employing the magnetic tape outputs of the computer to feed data into two electronic printing systems capable of producing over 260,000 address labels per hour.

HIGH-SPEED PRINTING OF MAGAZINE ADDRESS LABELS

MAGAZINE publishers and other organizations with volume mailing problems are constantly searching for more efficient methods of maintaining the integrity of their mailing lists and transferring address information to the products being mailed. For example, Time Inc., publisher of *Time*, *Life*, *Fortune*, and *Sports Illustrated*, requires as many as 200,000 changes daily in order to keep its master files of subscriber data up to date. It also must print more than 10 million address labels per week for the distribution of its magazines.

Subscriber data are maintained in an updated condition by means of an International Business Machines Corp. computer. Output from the computer is in the form of digitally coded data on magnetic tape. Each reel of tape holds from 70,000 to 90,000 different blocks of subscriber data. In order to use this efficiently generated subscriber data, A. B. Dick Co. developed a high-speed electronic printing system capable of translating the digitally coded information on the magnetic tapes to alphanumeric printing signals and then printing magazine labels at a rate in excess of 130,000 per hour. Two such systems have been installed in the Chicago offices of Time Inc. to handle the printing of more than 260,000 labels per hour, *Fig.* 1.

Each electronic printing system consists of two units. One is a tape reader and buffer unit which reads the magnetic tape record, edits the data to eliminate non-print subscriber records, stores the selected data, and provides a continuous flow of information to the printer. The second unit, a label printer, converts the digital codes from the buffer unit into printing signals and produces the magazine labels.

Converting Tape Data

The tape reader and buffer unit, *Fig.* 2, is provided with two tape reading positions so that an operator may load a tape reel while another tape reel is running. The unit automatically switches to the tape in the stand-by position when the running reel is at the end of its recorded data. Logic and control circuits in the unit reject dead records and non-printing portions of live file records. Printable data are edited, and properly coded signals are delivered to the printer in the line-to-line sequence desired on the finished labels. A 144-character circulating buffer permits repetitive printing of the city-zone-state line. This feature eliminates repeating this line of

information for each subscriber on a file tape and conserves computer time and tape. Sufficient buffer storage capacity is provided for live records so that 84 dead records can be rejected sequentially without producing a blank label.

The label printer unit consists of three sections, namely, paper supply, printing, and take-up. In the paper supply section, *Fig.* 3, a turret assembly supports two rolls of Videograph paper, each roll being 18¾ inches in diameter and 2¾ inches wide. While one roll of paper is being fed through a splicer, a cut-over accumulator, and into the printing section, the second or stand-by roll can be loaded onto the turret spindle and threaded into the splicer. When the running roll is depleted, the stand-by roll is automatically spliced to the active web, and the turret rotates slowly to bring the stand-by roll into the feed position. During the splicing operation, the paper web is stopped momentarily, but the supply of paper in the cut-over accumulator continues to feed the printing section without interruption. Each roll of specially treated paper supplies about 85,000 address labels and feeds the printer for about 40 minutes.

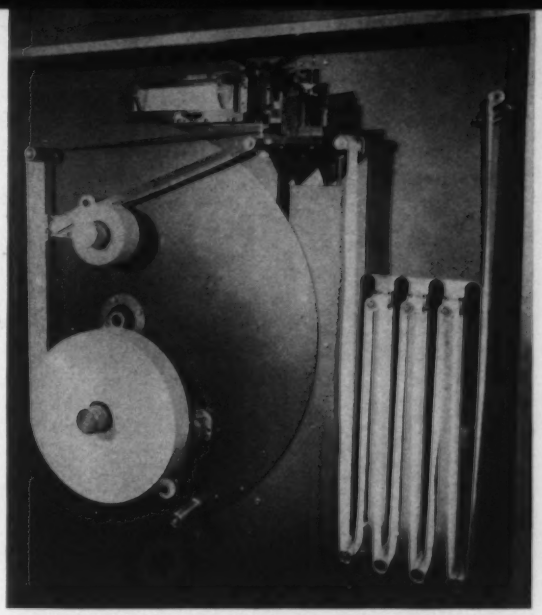


Fig. 3—Paper supply section of the printer holds a roll of paper being printed and a stand-by roll. When the running roll nears its end, an automatic splicer at the top of the unit splices on the stand-by roll. The accumulator at the right continues to feed paper at a constant rate to the printer during the momentary stop necessary for splicing.

▸ Printing and Fusing

The printing section of the unit, *Fig.* 4, accomplishes three processes, namely, imaging, developing, and fusing. In operation, a character generator converts digital input signals from the tape reader and buffer unit into alphanumeric television type signals which operate an electrostatic printing tube. As many as 64 different character symbols may be generated at rates in excess of 20,000 symbols per second. The cathode ray type printing tube has a wire matrix constructed in its viewing end. In response to input signals, a modulated electron beam sweeps across this matrix and electrically charges selected wires in the patterns of the characters being formed.

The specially treated paper web is passed in front of the wire matrix in the printing tube at a speed of 36.5 inches per second. Electrostatic charge patterns in the shape of latent character images are transferred to the web at a rate of over 6000 characters per second. The web then enters a developing unit in which rotating magnetic drums brush a thermoplastic, resinous toner powder over the surface of the electrostatically charged paper. At this point the image becomes visible since the black toner particles adhere to the charged character images on the web.

The web next enters an infrared fusing unit where the character images are permanently fused to the paper. The fuser generates sufficient heat upon the paper surface to melt the toner. The temperature of this unit is controlled by a variable transformer connected to a heat sensor which measures reflected heat from the moving web. In the event of a shutdown for any reason, the paper web is automatically lowered from the fuser to prevent burning.

Fig. 2—Each label printing unit is fed subscriber data from a tape reader and buffer unit equipped with two tape reading positions. The operator is shown loading a reel of magnetic tape from the computer into one position of the tape reader. Each reel of tape contains data for 70,000 to 90,000 subscribers. The reader and buffer unit reads the tape, edits out non-printed information, and transmits the edited information to the character generator of the label printer.

▸ Take-Up Unit

The third section of the printer is the take-up unit, *Fig.* 5. As the paper web leaves the printing section, it enters a drive mechanism which is coupled with

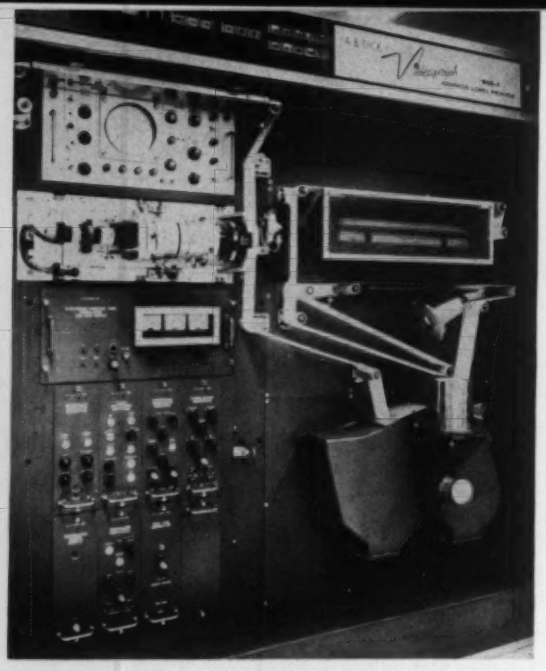


Fig. 4—This view shows the printing section of the unit. At the lower left is the control panel for the character generator which converts digital signals into alpha-numeric symbols. Immediately above the control panel is the electrostatic printing tube which transfers charged character patterns to the moving paper web at a rate over 6000 characters per second. At the lower right is the developing unit where toner powder is brushed over the latent image. The web then moves under the infrared fuser at the upper right to permanently fuse the printing onto the paper.

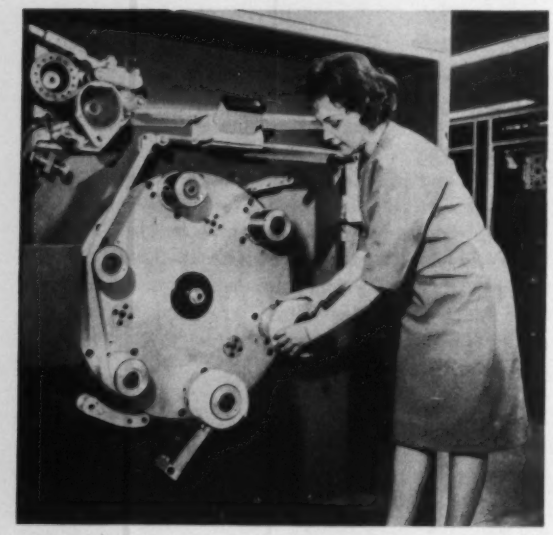


Fig. 5—The paper web from the printing section enters the take-up section of the unit at the upper left. After being hole punched, the web passes through an accumulator and then onto the 7 o'clock spindle of the 6-position take-up turret. Capacity of each spindle is 18,000 labels. When an end-of-roll signal is received, a high-speed knife is activated at the 9 o'clock position, the web is cut, and the leading edge of the cut web is forced against the vacuum operated empty reel to start a new roll. The turret then indexes the new roll into the 7 o'clock running position.

a rotary sprocket punch. Control hole punching of the web and synchronizing of input signals which feed the label information to the printer is also accomplished at this station. The web then passes through an accumulator which maintains constant web tension during the take-up operation.

Rewinding of the web is accomplished on a turret assembly which holds six take-up reels. The web is in contact with an empty reel in the 9 o'clock position of the turret and is actually rewound on a reel in the 7 o'clock position. The printer can be programmed to either produce a uniform number of labels per roll or to cut-off at any point in response to an end-of-roll signal from the input source. At the end-of-roll signal, a high-speed cutting knife opposite the 9 o'clock position cuts the web and forces the leading edge against the empty reel to begin a new roll. The turret assembly then indexes the running roll to the 7 o'clock position so that another empty reel is in position for the next end-of-roll signal. The operator may remove printed rolls of labels from any of the other spindles.

Other Applications

Variations of the electronic printing system can be used for many other types of data processing applications. In addition to magnetic tape, inputs to the system can be direct from a computer, from punched paper tape or punched cards, or from other sources. Scanning and printing units have been developed which are capable of transmitting and printing 10 pages of material per minute. Using wide-band facilities, the scanning unit scans documents of any length and transmits the intelligence in the form of video signals to a remote printer. The printer produces dry copies to the exact size of the original document. Other systems are designed for visual presentation of information on television monitors, etc., and permit high-speed readout from remote computers.

Several other types of systems are under development at the present time or are planned for the future. These include the following:

1. A high-speed copy reproduction system is under development for the Publications Div., U. S. Navy.

2. A random-access inquiry display system is being developed to provide instantaneous display on remote television receivers of computer-stored statistical information.

3. An electronic library information retrieval system has now proved feasible.

4. Under design is a high-speed digital plotter/printer system to plot curves and graphs and produce page print from a computer.

5. A remote electrostatic camera-printer system has been demonstrated that produces an instantaneous photographic record of moving objects.

6. A solid state "image bar" under development will permit high-speed scanning and printing of wide documents such as large maps, blueprints, etc. There will be no practical limitation on the width of document that such a system can handle.

Breakthrough . . .

IN AUTOMATIC ASSEMBLING MACHINES

by Swanson-Erie. These four machines—built around the new Swanson double tool plate chassis—provide multiple motion for piece part assembly. This concept in automatic machine design is another Swanson breakthrough in automatic assembly techniques.

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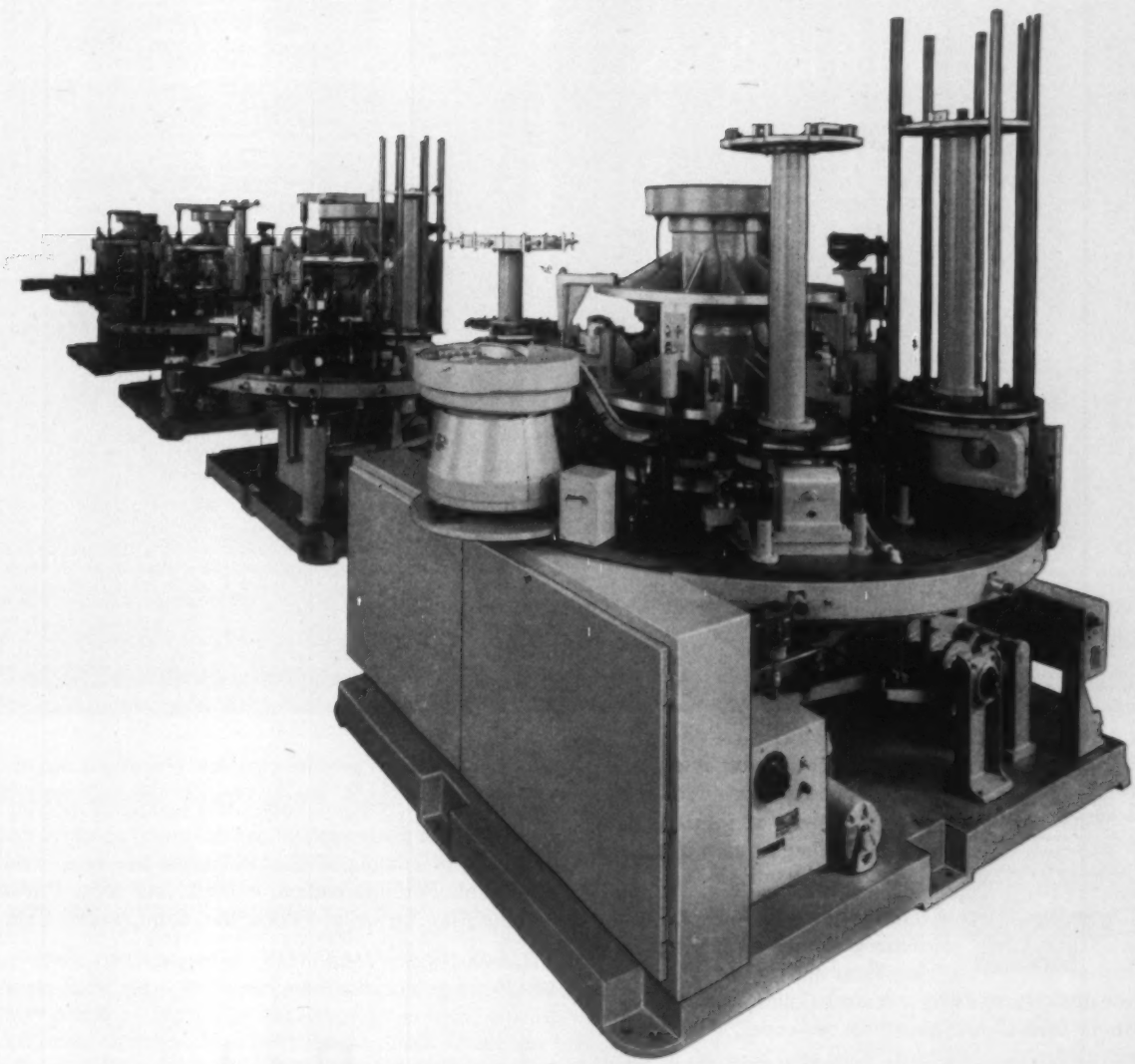

A booklet of our products and facilities is available on request.

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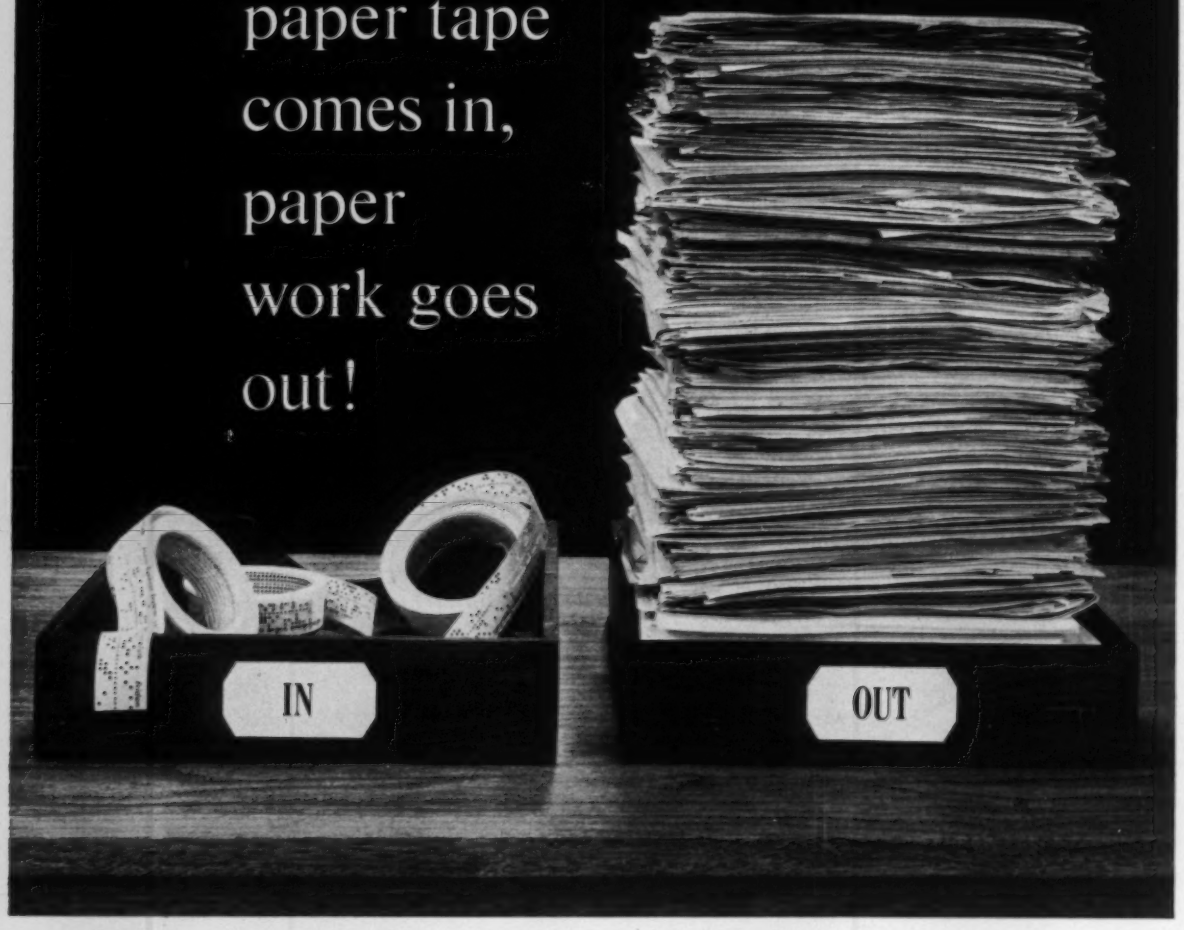
Circle 686 on Page 35

Collectadata: when paper tape comes in, paper work goes out!



The machine at left is a Friden Collectadata® Transmitter, key to a new system of internal data collection that virtually eliminates in-plant paperwork.

The system is very simple. Transmitters, spotted in key reporting locations throughout the plant, are cable-connected to a central Collectadata Receiver. "Blank forms" are issued as pre-coded tab cards or Friden edge-punched cards. Each card becomes a "filled-in" report after the worker inserts it in the transmitter, dials in any variables and touches a key. The rest is automatic. The receiver records each report in punched paper tape, adds an automatic time code. At day's end, the receiver tapes are processed—converted to tab cards or fed into a computer to prepare complete operations reports.

Collectadata users report substantial savings in time and money. But in many applications the *speed, accuracy and efficiency* of automated data collection are even more significant. For information, consult your local Friden Systems Man. Or write: Friden, Inc., San Leandro, Calif.

THIS IS PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it.

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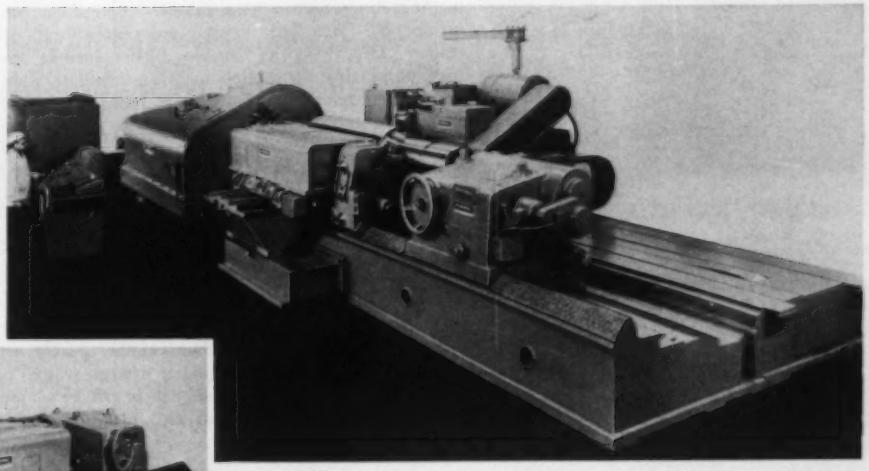
SALES, SERVICE AND INSTRUCTION THROUGHOUT THE U.S. AND WORLD

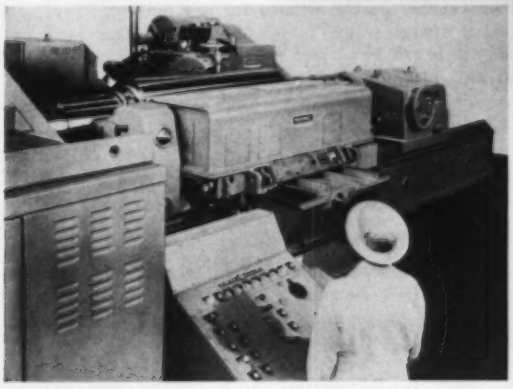
AUTOMATION

new equipment

Machines and plant equipment for more automatic operations.
For detailed information and literature, use card page 119.

Complete automation of this roll grinder is made possible by the incorporation of a unique wheel infeed system and by the addition of a probe table opposite the grinding wheel carriage. An automatic control directs the grinder through a complete cycle, performing all operations necessary to refinish a roll.





Probe table and control console of this precision grinder are illustrated in foreground. The control uses servo controlled positioning of probes to measure the diameter and profile of rolls being worked, and to detect work remaining to be done.

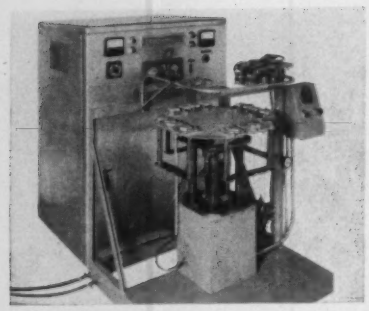
Numerically Controlled Roll Grinder

HEAVY-DUTY roll grinder, featuring a special General Electric numerically-addressed sequence and servo control, has been developed by **Farrel-Birmingham Co. Inc.**, Ansonia, Conn. The control device provides automatic tape-programmed control for refinishing rolling mill work rolls up to 60 inches in diameter. It provides precise straight or crowned profiles irrespective of roll diameter, requiring only one type of program tape for each type of roll profile worked. Grinder is capable of finish grinding a matching pair of work rolls to tolerances of ±0.001 to 0.0015 inch of desired diameter and of each other.

Operating from standard 1-inch punched tape, the automatic control will direct the grinder through a complete cycle, performing all operations necessary to refinish a roll. Once the operator starts the grinding wheel and pushes a cycle start button, the machine and control system, as programmed, takes over the work of rough grinding, aligning the workpiece, semifinishing, dressing the grinding wheel, finish grinding, and finally measuring and recording a printout of roll size. To do this, the control initiates 17 specific machine and control operation sequences as primary functions. It orders four other sequences as secondary functions, depending upon the state of specific machine devices.

Automation of the roll grinder was made possible by its unique system of bringing the wheel against the work and by the addition of a probe table opposite the grinding wheel carriage. Servo-positioned, hardened steel probes scan each roll to find the point of greatest wear. The control automatically sets this as a "bench-mark" for regulating grinding operations and final diameter. These steel probes also check to determine work remaining to be done during grinding and roll-matching.

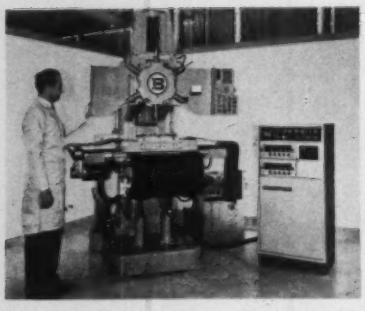
Circle 401 on Page 119



INDUCTION BRAZING MACHINE FOR PRODUCING THERMOCOUPLE ASSEMBLIES

Machine, capable of production rates up to 600 parts per hour, includes a Reevelec 7½ KW induction generator with indexing turntable. Also included are heat resistant part-holders, a special cooling assembly to cool parts down for handling, and a gage to align parts in the holder. Four parts are brazed at one time. Unit can be operated semi-automatically or manually. Parts are raised automatically into heating position and lowered when the induction generator completes the brazing cycle. **Reeve Electronics Inc.**, 609 W. Lake St., Chicago 6, Ill.

Circle 402 on Page 119



NUMERICAL POSITIONING CONTROL SYSTEM

Model M33 numerical positioning control system, combined with a turret drill, provides tape control for a third, or vertical axis in addition to regular longitudinal and cross axes. Feature of the system is that special engineering drawings are not needed. Dimensional information from customary drawings is utilized in decimal form with a tape preparation unit. The data is read by a photocell reader. Other features of the system include availability of different resolutions, high positioning speed (180 inches per minute), feed rate control if desired, auxiliary functions, decimal display of tape information, and choice of automatic, semi-automatic, and manual modes of operation. Tape reading speed is 100 lines per second. **Electronics Div., Rheem Mfg. Co.**, 5200 W. 104th St., Los Angeles, Calif.

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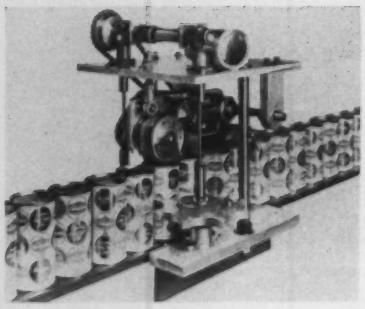
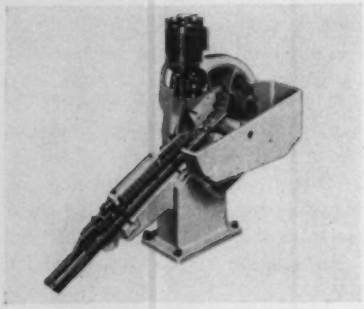


CAN IMPRINTING MACHINE ATTACHES TO PRODUCTION LINE

Designed to mark 1000 cans per minute, can imprinting machine features an automatic inertia device which keeps the star wheels in proper position and prevents them from overrunning. The machine can be easily adjusted for different can heights and diameters. Its printing drum can be quickly adjusted for spot printing. This imprinter has a flexographic inking system which uses a floating printing head for following the contours of a can top. It can be adapted for printing the bottom of cans. **Industrial Marking Equipment Co. Inc.**, 655 Berriman St., Brooklyn, N. Y.

Circle 404 on Page 119



PIECE-PARTS FEEDER AVAILABLE IN TWO SIZES

Small-parts feeder features a divided track, adjustable in width, which can be furnished for use with headed parts. It is designed in two sizes for operation with various types of assembly and other equipment. To provide for installation in close quarters, the width of both feeders has been held to a minimum by use of a horizontal-axis drum. This also allows for unusual bowl capacity. Model FE-101 (illustrated) is only 6 inches wide and has a storage capacity of 150 cubic inches. Model FE-104 is 10 inches wide and has a capacity of 700 cubic inches. The feeders can be furnished fully tooled for a job or with a blank track ready for machining to suit the part to be handled. **Dixon Automatic Tool Inc.**, 2300 23rd Ave., Rockford, Ill.

Circle 405 on Page 119

BULK WEIGHING SYSTEM FEATURES ACCURACY AND FAST OPERATION

Line of bulk weighing systems can provide accurate net weights of material with an accuracy of up to 1 part in 4000. Six models with capacities to over 3 million lb per hour are available. Central control console utilized by the systems is illustrated. This console contains electrical controls for the bulk weigher operation. Automatic adding machine is located under protective covering at right side of console. In operation, multiple drafts of material are weighed and the gross and tare weights of each draft are recorded upon the adding machine. Total net weights of these accumulations are always available. Fail-safe design and functional electrical interlocking assure accurate recording and results. **Toledo Scale, Div., Toledo Scale Corp.**, Toledo 12, Ohio.

Circle 406 on Page 119

General Electric Makes Eddy-current-coupling Drives

And they're dependable drives. The complete line includes water-cooled and air-cooled eddy-current couplings. We call them KINATROL* drives. Ratings are from 1 to 150 horsepower, operating from standard a-c power.

A General Electric KINATROL drive is not just another eddy-current coupling. For instance, in the water-cooled coupling, water control is packaged. You'll see much less external piping. Furthermore, the coupling is protected from flooding—and the air gaps are dry, preventing corrosion.

KINATROL couplings are compact, field proven and dependable. General Electric has had a good deal of experience in the engineering, manufacturing, and application of packaged adjustable-speed drives. And we know how important service is to a customer.

KINATROL —a good product, with the kind of service you can depend on. Please call your nearest General Electric Sales Office for further details.

*Trademark of General Electric Company

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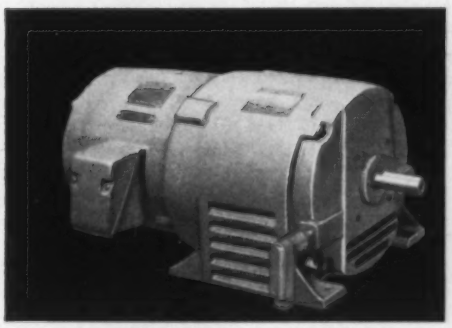
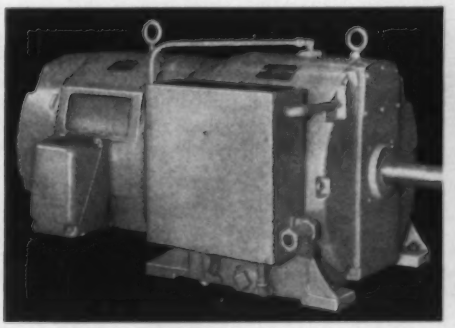


AIR COOLED, 7-1/2 to 100 HP



WATER COOLED, 25 to 150 HP

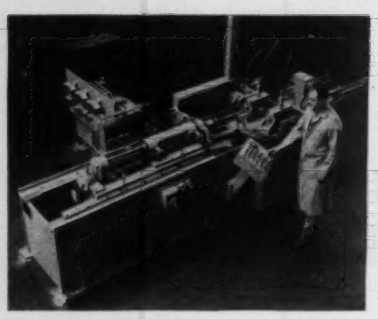
AIR COOLED, 1 to 5 HP

DIRECT CURRENT MOTOR AND GENERATOR DEPARTMENT

GENERAL ELECTRIC

ERIE, PENNSYLVANIA

Circle 688 on Page 35



HORIZONTAL STACK-FINISHING MACHINES

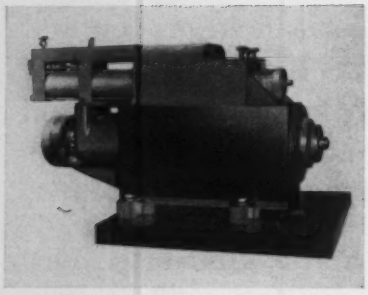
Line of horizontal stack-Microhoning machines, designated Model 5HXH-16, has been designed for finishing such parts as connecting rods and gears where the bore length is comparatively short with respect to bore diameter. The parts are stacked horizontally and Microhoned as one long part. Machines feature greater accuracy, longer tool life, and reduced cycle time. An automatic hydraulic probe prechecks for proper clearance in the bored holes. An integral shot-bolt locator provides for positive positioning of the indexing fixture. Larger distribution lines assure maximum coolant flow to facilitate removal of swarf from the work area. Micromatic Hone Corp., 8100 Schoolcraft Ave., Detroit 38, Mich.

Circle 407 on Page 119

PRECISION SORTER FEATURES FLEXIBILITY

High-speed, precision or gaging machine is used to segregate items according to size or shape. It can be changed over from one item or size to another by means of a few screw adjustments in a matter of minutes. This precision sorter is used to sort or gage items for thickness or diameter. It sorts parts such as washers, nuts, and disc shaped objects for thickness only. Cylindrical parts are sorted for diameter. Screws, rivets, and other headed items can be sorted for head diameter. The sorter will gage parts at speeds up to 2000 parts per minute with a maximum error of ±0.0003 inch. The number of sorting stations can be varied between 1 and 10 to meet individual requirements. Count-O-Matic Inc., 40-28 22nd St., Long Island City, N. Y.

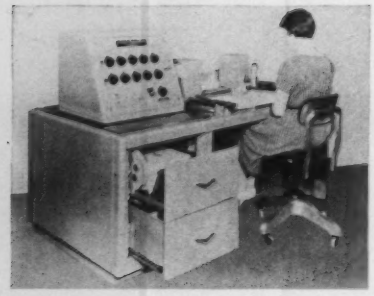
Circle 408 on Page 119



SELF-PROPELLED MINIATURE BORING SPINDLE

Precision boring spindle assembly has been developed as a module for use in the instrument and small-parts industries. It has up to 2-inch axial travel and has exhibited a rotational error of less than 0.00003 inch and a travel error of less than 0.00005 inch in its entire range of travel. Equipped with micrometer depth control, the spindle repeats to within 0.0002 inch, with fast infeed, controlled boring feed, and dwell time all precisely variable. Boring speeds range from 1000 to 15,000 rpm. By using several units as modules or building blocks mounted on a surface plate, multidirectional miniature boring machines can be assembled, and revised for changing needs. Whitnon Mfg. Co., Route 6 & New Britain Ave., Farmington, Conn.

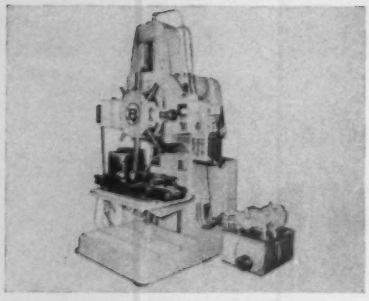
Circle 409 on Page 119



TAPE PROGRAMMER WORKS DIRECTLY FROM ART DRAWINGS

Independent tape programmer has been developed to prepare conventional 1-inch wide, 8-channel tapes for drilling printed circuit boards directly from art. It can be used with any conventional tape controlled printed circuit driller. This machine enables the operator to locate up to 30 positions per minute. It can be used for preparing tapes during the time that the drilling machine is being used to drill printed circuits boards. This programmer covers an area of 24 by 24 inches and handles virtually all grid sizes with the use of interchangeable slides arranged for 0.1, 0.05, and 0.025-inch grids and art scales of 1:1, 2:1, and 4:1. Odd size grids such as 0.14 inch and grids that vary from X to Y axis are also handled easily. Edlund Machinery Co., Dept. P., Cortland, N. Y.

Circle 410 on Page 119



INDEXING SLIDE TABLE PACKAGE

Automatic multiple work positioning in any desired cycle can readily be provided on both standard and special machine tools with this indexing slide table package. Equipment includes: Heavy duty slide table with hardened steel ways and T-slots; multistation indexing mechanism with replaceable index control bar; portable electrohydraulic power pack with reservoir; automatic-manual remote control station that can be mounted at any convenient location. Slide table can be used either as built-in original equipment on a special machine tool, or as productive attachment for various machines where the tooling feeds into the work. With a controlled feed rate, the slide can also be used to advantage on certain milling and slotting operations. Russell T. Gilman Inc., 623 Beech St., Grafton, Wis.

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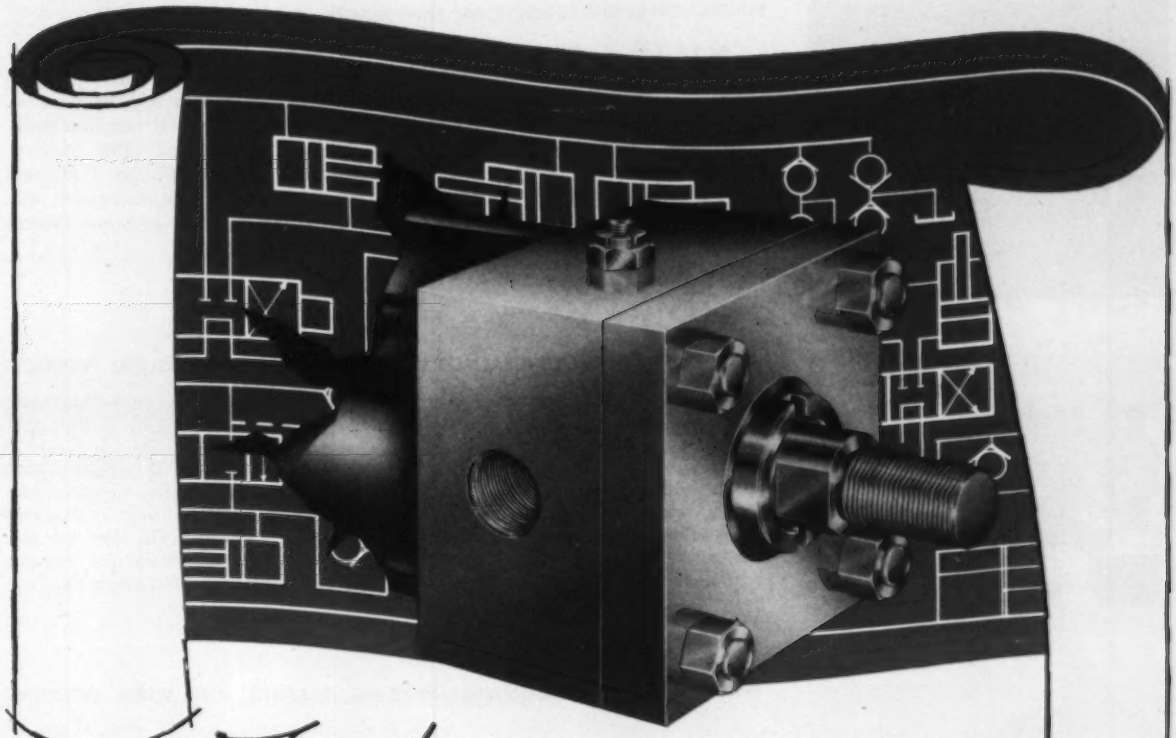

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From its blueprint stage to its maintenance engineering requirement sheet, your product will assure MORE power drive precision and service, if T-J cylinders are specified. T-J's complete line too, from the Spacemaker to the new replaceable Squair Head, can be the answer to any power problem. Write or call The Tomkins-Johnson Company, 2425 W. Michigan Ave., Jackson, Michigan, today!

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STANDARD HYDRAULIC

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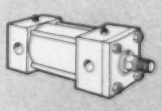

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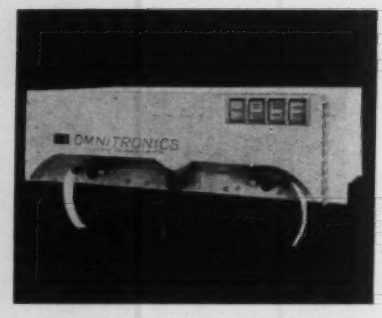
Circle 689 on Page 119



BIDIRECTIONAL PHOTOELECTRICAL TAPE READER

Model PTR-71 will read all standard tape widths and up to 8 channels plus sprocket in either strip, loop, or reel tape modes at any one of 9 standard speeds up to 100 ips. It is ideal for reliable tape reading applications such as input to digital computers, communication systems, tape converters, ground support equipment, checkout equipment, numerical machine tool control, and other punched tape programmed equipment. The bidirectional drive feature facilitates a different tape speed for forward and reverse directions. An increased signal-to-noise ratio is achieved through the application of reflected chopped light in the actual reading process. **Omnitronics Inc.**, 511 N. Broad St., Philadelphia 23, Pa.

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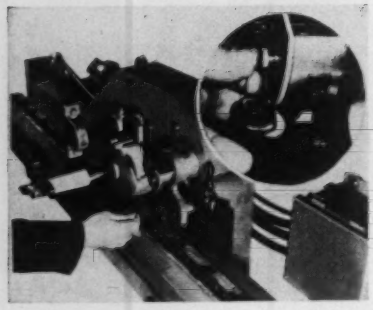

IN-LINE OFFSET PRINTER IDEAL FOR USE ON ALL TYPES OF INDUSTRIAL PRODUCTS

Model 6519 can be installed over present conveyor lines or it can be used with dial feed tables, and other parts handling systems, for automatic marking of capacitors, resistors, and other small rectangular or cylindrical parts (as small as 3/16 by 1/4 inch in size). The printer will meet minimum or maximum line speeds with consistent high quality printing. The offset method provides fast, legible printing of parts with flat or uneven contours. Each unit is equipped with paste-type ink fountain, adjustable doctor blade, and steel dip type ink roll. Die roll and blanket roll of offset unit have micrometer adjustment for precision control of printing. **Jas. H. Matthews & Co.**, 3942 Forbes St., Pittsburgh 13, Pa.

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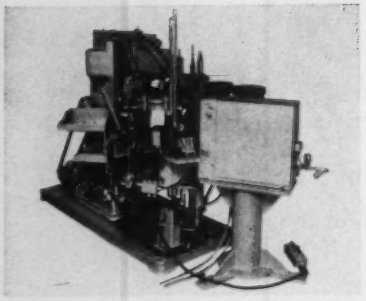

DIAL TYPE MACHINE COMBINES WELDING, TAPPING, AND SCREW INSERTING

Machine has been developed to cut production costs on a relay terminal contact. The small workpiece is fed automatically into a fixture from an inclined track. The dial, indexing counterclockwise, passes through stations where the following operations are performed. Check for presence of terminal; transfer and position square of bimetallic contact tape—weld contact in place on terminal; inspect for weld; tap 8-32 hole; insert 8-32 binder head screw; eject completed assembly; check for empty station. Production on this machine is 10,000 to 12,000 pieces per shift. Special features include ability to process either right or left hand pieces, and positive mechanical advance of welding electrodes from one central camshaft. **Bodine Corp.**, 317 Mt. Grove St., Bridgeport, Conn.

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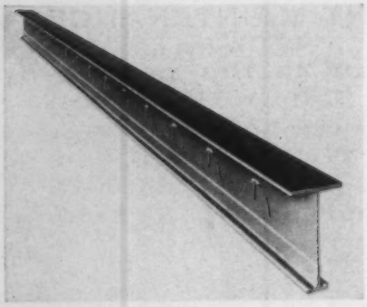

OVERHEAD MATERIALS HANDLING TRACK

Heavy-duty track, designed for overhead materials handling service, is capable of withstanding heavy, swinging, jerky loads and provides a smooth trouble-free road for materials movement. Tarca Track is fabricated in a large number of standard sizes ranging from 8 to 20 inches deep. Special sizes and greater depth tracks can also be made. This track can be used for either hand-power or electrified installations and may be connected to track switches. Systems can be developed for nearly every handling situation requiring straight or curved tracks for all loads up to 20 tons. Standard tracks are available in lengths to 60 ft. Standard deflection of the track will not exceed 1/450 of a span. **Cleveland Tramrail Div., Cleveland Crane & Engineering Co.**, Wickliffe, Ohio.

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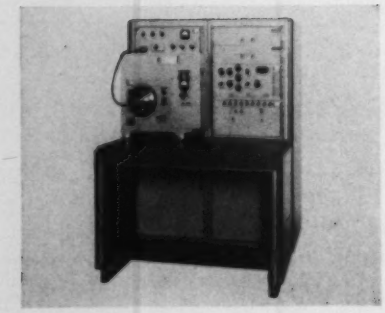


SYNCHRO-RESOLVER TESTER

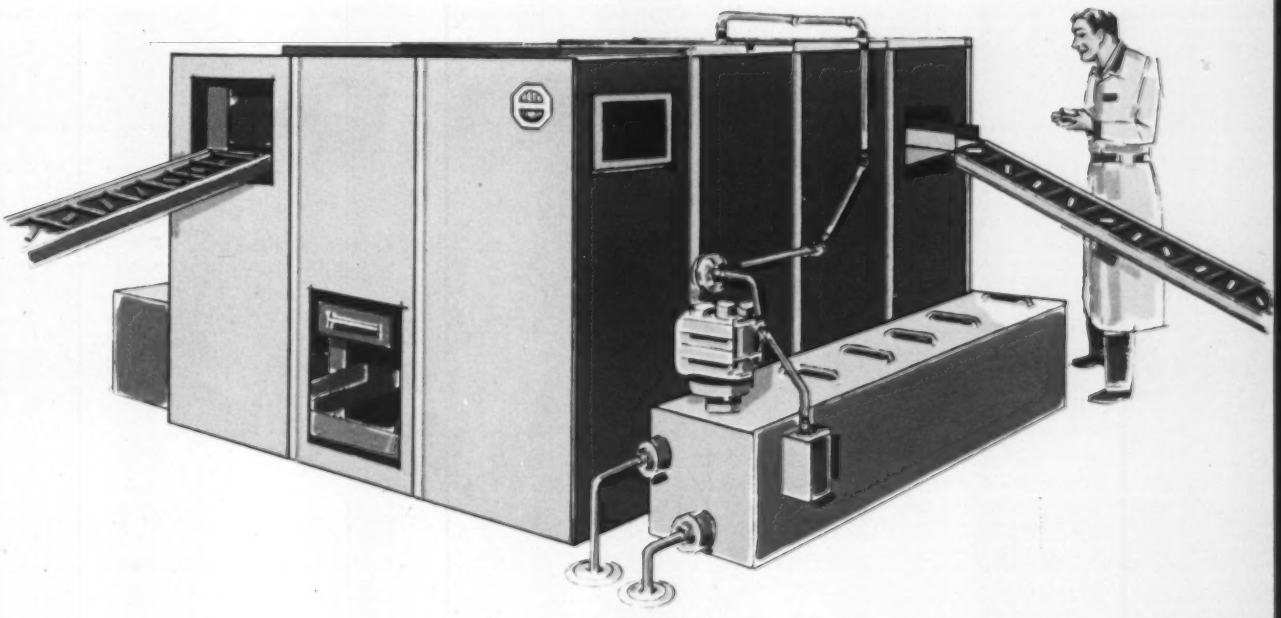
Unit is especially designed to meet all of the electrical requirements of MIL-S-20708A. It performs the following tests automatically on 60 and 400 cycle synchros or resolvers from MIL size 08 through 37: No-load quadrature current (±3 per cent), no-load reference current (±3 per cent), fundamental null voltage (±3 per cent), total null voltage (±3 per cent), transformation ratio (±0.2 per cent), error from electrical zero (±30 seconds), and phase shift (±1 degree). Five of the six modules comprising the unit are designed for standard 19-inch rack mounting, and the index module projects from the front of the rack for maximum ease of operation. **Kearfott Div., General Precision Inc.**, 1150 McBride Ave., Little Falls, N. J.

Circle 416 on Page 119

***Automatic continuous or automatic batch-type finishing can be yours with the* NEW**

AUTOMATIC VIBRATRON®

by ROTO-FINISH/RANSOHOFF



IN LARGE PLANTS OR SMALL PLANTS, for continuous production or batch-type production, this new ***automatic*** *system cuts finishing costs.*

Eliminate direct labor. Reduce compound and media cost. Simplify materials handling, and improve quality . . . with the New Automatic Vibratron. You can place this machine ***anywhere*** *in your production line.*

Read How It Does More Work In Less Time At Lower Cost

See the Automatic Vibratron in operation at the Detroit Metal Show, Booth 1120. October 23-27

ROTO FINISH

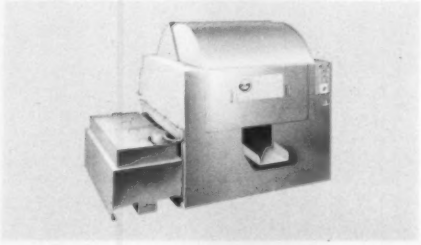
BIG SAVINGS in Automatic Finishing Are Now Possible with the New

AUTOMATIC VIBRATRON®

For complete production flexibility, the Automatic Vibratron is available in two basic types, the Batch Automatic for batch production, and the Continuous Automatic for continuous production. Each is available in a complete range of sizes and capacities.

BATCH-TYPE AUTOMATIC VIBRATRON

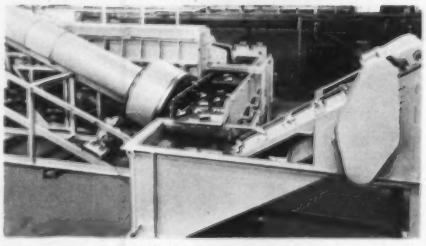
This revolutionary design eliminates direct labor. Can be integrated with existing production equipment *anywhere in the plant.* The only facilities required are electric power, water, and your plant drain. Parts are introduced to the machine, processed, and separated *automatically.* Are fed to the machine by tote box, conveyor, or accumulating hopper. Machine cycling is timer sequenced.



CONTINUOUS AUTOMATIC VIBRATRON

The Continuous Automatic Vibratron finishes parts on a continuous through-feed basis. No operator is required. Any process, or combination of processes can be provided. Media re-sizing, rinsing, compound recirculation, parts separation, and drying are *all automatic.*

Automatic Vibratrons are now deburring automotive transmission valves . . . preparing zinc die castings for electrostatic painting . . . finishing golf club heads for plating . . . deburring complex, 14" long die castings . . . and final finishing precision rollers for bearings to 4 micro-inch smoothness.



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ROTO-FINISH/RANSOHOFF
3700 MILHAM ROAD
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GENTLEMEN: Please furnish us complete information on the Automatic Vibratron. We are interested in ( ) Continuous Automatic Finishing ( ) Batch-Type Automatic Finishing of _____.
(indicate part to be finished)

It is made of _____.
(type of metal or material)

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

WORLD-WIDE SKILL AND EXPERIENCE

UNITED STATES - Roto-Finish Company - Kalamazoo, Michigan / Ransohoff Company - Hamilton, Ohio
ARGENTINA - Roto-Finish Argentina - Buenos Aires
AUSTRALIA - A. Flavell Ltd. - Victoria / BRAZIL - Roto-Finish - Sao Paulo / CANADA - Canadian Hanson & Van Winkle Co., Ltd. - Toronto
ENGLAND - Roto-Finish Ltd. Hertfordshire
FRANCE - Societe Roto-Finish - Paris / GERMANY, AUSTRIA, NORWAY, DENMARK, PORTUGAL, SWEDEN, SWITZERLAND, YUGOSLAVIA, JAPAN - Matallgesellschaft A.G. - Frankfurt, a.m. - Germany
HOLLAND, BELGIUM, LUXEMBURG - N.V. Roto-Finish Maatschappij-Delft, Holland
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SPAIN - Institute Electroquimico, S.A. - Barcelona

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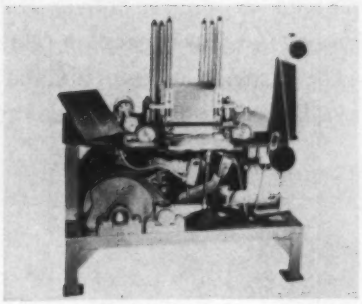

BOXBANDER HANDLES UP TO 1800 PACKAGES PER HOUR

Fully automatic boxbander facilitates inventory control, provides visual recognition of full containers, and allows multiple banding of products for special promotions. It reduces soiled and damaged merchandise and eliminates pilferage of products displayed in open containers (original design developed for hosiery industry). The machine does not have to be stopped to feed the hopper. It utilizes any type of heat seal material and can be provided to take any band width from ¼ inch and up. A tear tab is provided for easy package opening. The boxbander utilizes plain or printed bands. It registers control for exact band location and cutoff available on request. Speed of operation is up to 1800 packages per hour. **Halm Instrument Co. Inc.**, Glen Head Rd., Glen Head, L. I., N. Y.

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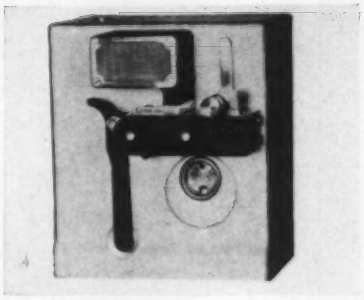

ANEMOMETER READER RELIABLE AT HIGH AND VARYING SPEEDS

Anemometer (hot-wire) tape reader offers extreme reliability in high speed tape reading as well as at varying speeds from static to more than 500 inches per second. In operation, a vacuum unit attempts to draw air through the tape into apertures for each level on the tape. A hot-wire element bridges each aperture and forms part of a bridge circuit. Pattern of holes in a tape is sensed by change in voltage of the bridge circuits as air passes over the hot-wire elements. Servicing is every 1000 hours when operated at 300 codes per second and proportionately longer when operated at lower speeds. The FRA-1 is capable of reading standard 5, 6, 7, or 8 hole tapes, transparent or opaque, and all grades of paper or plastic. **Soroban Engineering Inc.**, Box 1717, Melbourne, Fla.

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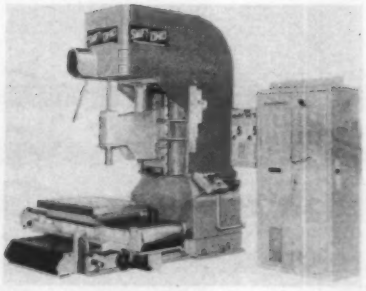
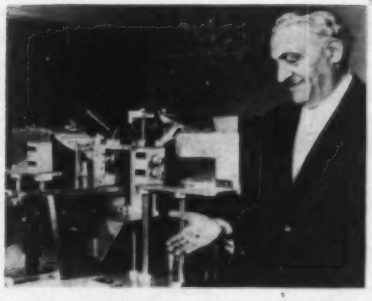


HEAVY DUTY DRILL AUTOMATICALLY OR MANUALLY CONTROLLED

Drilling, boring, tapping, and positioning operations of the No. 425 upright heavy duty drill can be automatically or manually controlled. Production applications of the machine include job shop, maintenance department, and limited production of like configuration parts. The drill eliminates the need for extensive setup, jigs, fixtures, and large inventories. It has a numerically controlled 24 by 36-inch compound table, hydraulic feed to spindle, 18 spindle speeds ranging from 52 to 2250 rpm, and fine and coarse feed range provided by quick change, two-speed gear range. Repeatable electrical accuracy of the automatic control (General Electric Mark II) is ±0.0005 inch. **Swift Ohio Corp.**, Kenton, Ohio.

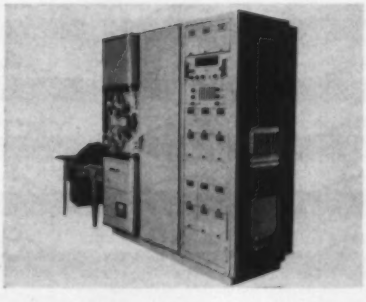
Circle 419 on Page 119



MACHINE ASSEMBLES 6000 TRANSISTOR HEADERS PER HOUR

Header assembly machine can be adapted to many different precision operations including welding, punching, and threading. As many as 40 different kinds of parts can be assembled at the same time. For header assembly operations the machine inserts tiny wires 18 thousandths of an inch thick and 15 hundredths of an inch long into minute holes in a carbon "boat," used as a carrier for the assembly. The machine then deposits Kovar shells or frying pans into nests on the boat. Then three wires 18 thousandths of an inch in diameter and 1.7 inches long are inserted into each nested frying pan. A glass disc and a carbon disc are inserted over the long wires. The boats are conveyed to an oven for the final fusing operation. **Rhebo Corp.**, 1108 W. Evelyn Ave., Sunnyvale, Calif.

Circle 420 on Page 119

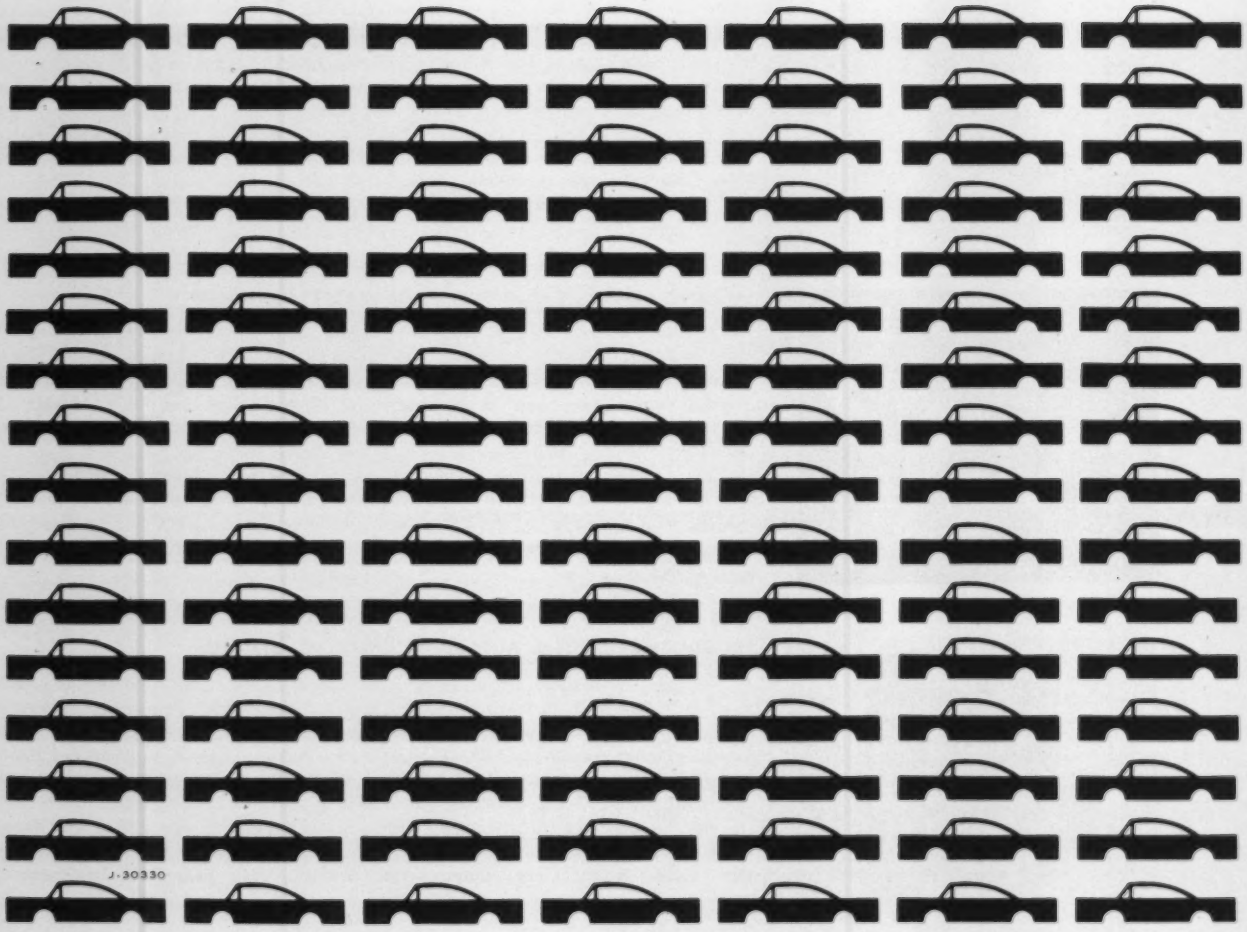


PROGRAMMED DIGITAL AUTOMATIC CHECKOUT SYSTEMS

Designed to facilitate quantitative, qualitative, and Go-No-Go testing of equipment and systems at all levels of maintenance and production, these digital automatic checkout systems are essentially programmable control units. They direct input-output switching, select measurement scales, and compare system responses to predefined limits related to a specific stimulus. Digitally controlled, they utilize solid state electronics throughout with either magnetic or punch tape as the programming medium. Through the use of modular construction techniques, systems tailored to cope with a wide range of checkout problems of varying degree and complexity can be supplied. **Electronics Div., Curtiss-Wright Corp.**, Intermountain Branch, P. O. Box 10044, Albuquerque, N. Mex.

Circle 421 on Page 119

The Westinghouse BF Relay is helping the automotive industry solve its floor space problem. One automotive customer was able to reduce the length of a single control panel from 36 feet to 22 feet. Another eliminated one of three panels. The Westinghouse BF Relay is a new concept in relay design tailored to space-saving needs of automation. As many as four BF Relays fit in the space of

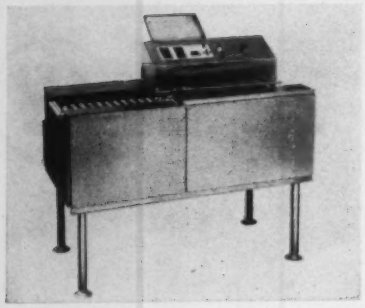


one old style relay. Besides being small, performance excels other machine tool relays. Learn how it can help you gain valuable floor space for more productive uses. Contact your Westinghouse sales engineer or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pennsylvania. *You can be sure . . . if it's* **Westinghouse**

Automotive industry saving thousands of dollars in floor space with the new Westinghouse BF Relay

Westinghouse BF Relays control six transfer lines built for the automotive industry by F. Joseph Lamb Co., Detroit.

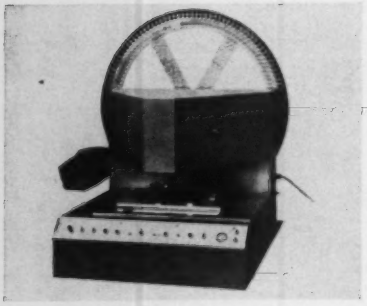
Circle 691 on Page 119



CLASSIFIER OFFERS 5-WAY WEIGHT SORTING

Weighing of packaged merchandise is speeded and refined in this 5-way classifier. The equipment weighs in motion at production line speed for sorting underweights, overweights, and onweights into five separate channels to simplify makeup or take-away in package contents. In addition to under and overfill control, the equipment has broad application such as portion and quality control by weight, and counting and grading by weight. Package weight range is up to 10 lb at speeds up to 300 units per minute. Accuracy is ±1/32 oz, and range is adjustable from 1/10 to 2 oz. **Illumitronic Systems Corp.**, 680 E. Taylor, Sunnyvale, Calif.

Circle 422 on Page 119



PROGRAM DRILL FEATURES MECHANICAL OPERATION

High-precision program drill, with simple mechanical programming and operation, will automatically drill any preselected pattern of holes, up to 200 in number, through a load of one or more printed circuit boards, up to 8 by 12 inches in size. Repeatable accuracy for any number of loads remains within 0.002 inch. The Drill-Amatic Model 120 consists basically of a high-speed electric drill with a pneumatically operated spindle and a movable worktable controlled by a program of paired stop-pins set in a revolving control disc. Programming is accomplished simply by adjusting the stop-pins to the desired length with a micrometer and setting them by hand into the disc. Each pair of pins controls the position of one hole. **Develop-Amatic Engineering**, 923 Industrial Ave., Palo Alto, Calif.

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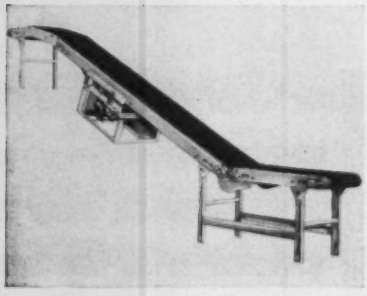

BELT CONVEYORS DESIGNED FOR CUSTOMER ASSEMBLY

Many different conveyor combinations can be assembled from standard stock Series K components which feature simple, Unibilt, bolt-together construction requiring no special tools. Standard end units, bed sections, drives, vertical curves, end take-up units, and loading sections come in standard 12, 18, and 24-inch belt widths. Other widths are available. The units are all interchangeable and feature interlocking channel construction to assure accurate alignment and rigidity. **Conveyor Specialty Co. Inc.**, North Quincy, Mass.

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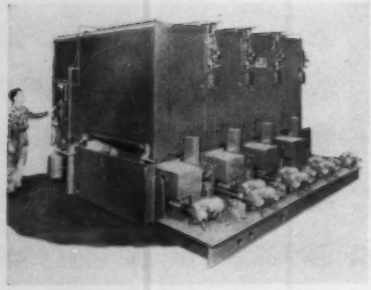


MULTIPLE HEAD GRINDING AND POLISHING MACHINE

Four-head grinding and polishing machine for the progressive finishing of stainless steel coiled strip will process material 0.010 to 0.250 inch thick and 50 inches wide. The entire unit requires only half the floor space of four conventional strip grinders, and its flexible design permits the addition of any number of additional grinding heads. This machine is ideal for either wet or dry operation. Each grinding head is composed of an endless abrasive belt running over a two-roll head with a motorized adjustable steel billy roll for increasing the belt pressure against the steel strip. The belt on any head can be changed while the others are in operation. **Hill Div., Hill Acme Co.**, 1205 W. 65th St., Cleveland 2, Ohio.

Circle 425 on Page 119

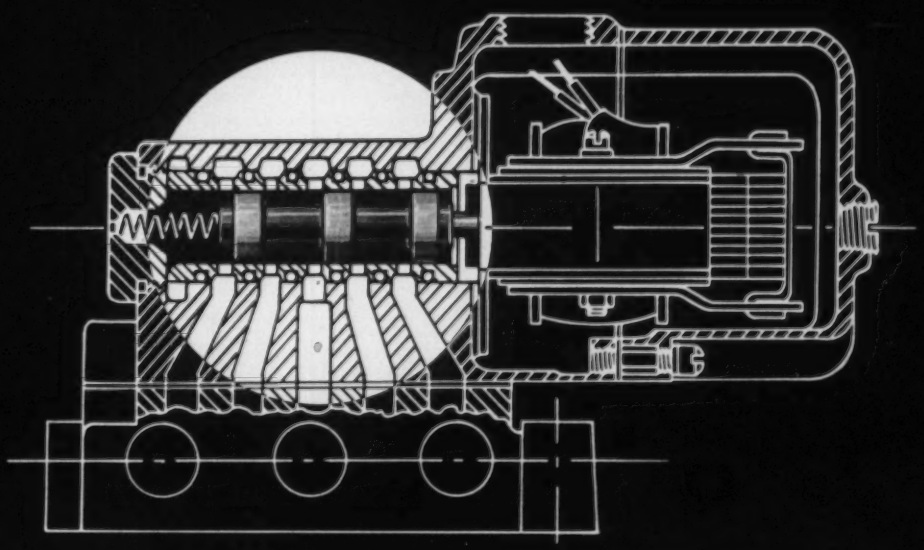
INDEXING AND ROTARY TABLES

Standard rotary tables and indexing tables completely mounted and tooled are available for automating or semi-automating soldering and brazing operations using the Fusion paste method. The machines are complete with a paste applicator, natural gas and air burners, and motor driven or air operated tables with two-foot diameter ceramic table top and mounted on rugged steel frames. Fixtures to hold the parts and method of loading parts onto the table must be added. Tables are capable of handling 200 lb of parts. **Fusion Engineering**, 17921 Roseland Ave., Cleveland 12, Ohio.

Circle 426 on Page 119

NUMATICS *makes a superior valve—*

a simple, versatile valve!

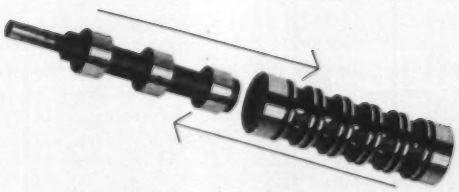


It works...

and works...

and works!

TO FIND OUT WHY CONTACT



Famous floating sleeve-lapped spool design.

NUMATICS, Inc.

Highland, Michigan

Circle 692 on Page 35

COMPUTER FEATURES ALL-TRANSISTORIZED 5 MC CIRCUITRY

Packaged in an office desk, the Model 160-A computer is equipped with an expandable magnetic core memory of 8192 computer words, buffered input and output, program interrupt, and a list of 91 instructions. Its basic magnetic core memory can be expanded in modules up to 32,768 words. Applications include commercial data processing, engineering problem solving, off-line data conversion, scientific data processing, etc. A variety of peripheral equipment can be added to the computer according to specific requirements. **Computer Div., Control Data Corp.,** 501 Park Ave., Minneapolis 15, Minn.

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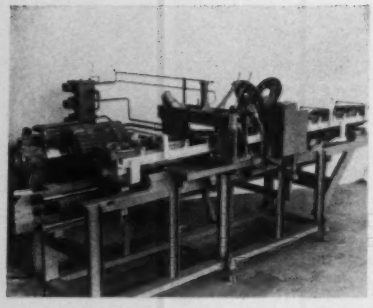

TRANSFER UNIT POWERED BY A SINGLE HYDRAULIC CYLINDER

Standard transfer unit of the walking beam type reaches into a press, removes the part directly from the die and progresses it along. At the center of the illustrated unit (designed for automotive part production) is a turn-over device which orients the part automatically for the next two operations. A hydraulically powered piercing unit performs an auxiliary piercing operation while the workpiece is transmitted between presses. The workpiece, after the piercing operation is performed, is transferred through and deposited directly into a staking die in another press. The transfer unit is powered by a single hydraulic cylinder with actuated patented interlocking mechanisms that provide the upward and linear motion. Interlocks are all mechanical. **Livernois Engineering Co.,** 25200 Trowbridge, Dearborn, Mich.

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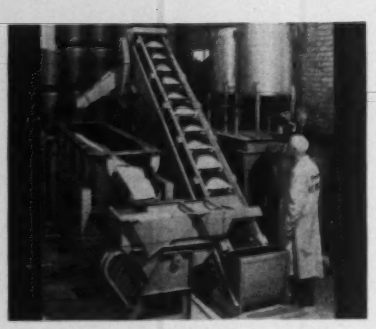

CONTINUOUS FINISHING MACHINE RECYCLES MEDIA

Continuous, high production precision finishing of metal, plastic, or ceramic parts is made possible by use of this line of fully automatic continuous process vibratory gyrators. Work may be fed or conveyed automatically into and out of these machines. Media are cleaned, screened, and recirculated. Compound and water are also added automatically. Cleaning, descaling, deburring, grinding, fine-finishing coloring, and burnishing may be accomplished with the same precision as in standard type operations. The machines use the same gyratory action and special air-cushion suspension as standard type units. Continuous conveyance of fixtured large and heavy parts through these machines is possible. **Pangborn Corp.,** Hagerstown, Md.

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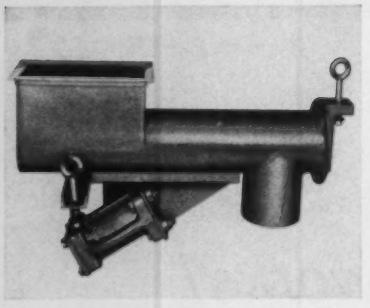

TUBULAR PNEUMATIC FEEDER

Model NFT 4-840 has a tube 8 inches in diameter by 40 inches long. It uses an air vibrator that consumes only 16 cfm at 50 psi. The feeder features a one-piece vibrator design with a silent type vibrator piston as the only moving part. It requires no expensive stock of spare parts and cuts vibrator maintenance up to 80 per cent. Vibrators can have tapped ports for exhausting directly to remote areas in food or pharmaceutical plants. Feeder can be furnished in carbon steel, stainless, or aluminum. A wide range of flow rates can be obtained by varying the air pressure range from 20 to 70 psi. Solenoid valves can be arranged for automatic control. **National Air Vibrator Co.,** 435 Literary Rd., Cleveland 13, Ohio.

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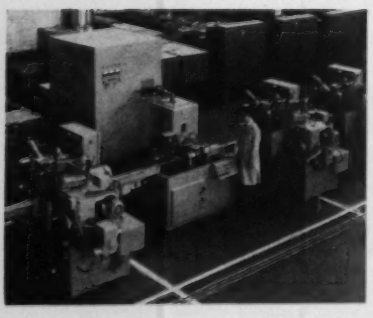


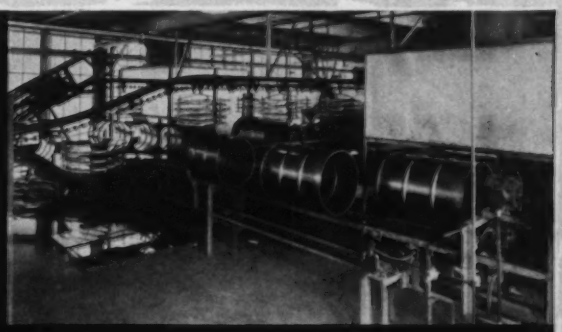
CENTERLESS GRINDER LINE INCLUDES INDUCTION HEATING MACHINE

Precision production line automatically hardens parts as they progress from the No. 1 to the No. 2 Centerless grinder in the line. A continuous flow of workpieces (shock absorber piston rods) pass through this production line at the rate of 12 ft per minute, or 960 parts per hour. At the beginning of the line a hopper feeds the parts into the first grinder for primary grinding, removing about 0.006-inch stock. The next machine is a 50 kw radio frequency induction heating machine. From the induction heating machine, parts are automatically conveyed to four in-line No. 2 Centerless grinding machines for finish grinding. Stock removed by these four machines is 0.004 inch, 0.002 inch, 0.001 inch, and 0.0005 inch respectively. **Meta-Dynamics Div., Cincinnati Milling Machine Co.,** Cincinnati 9, Ohio.

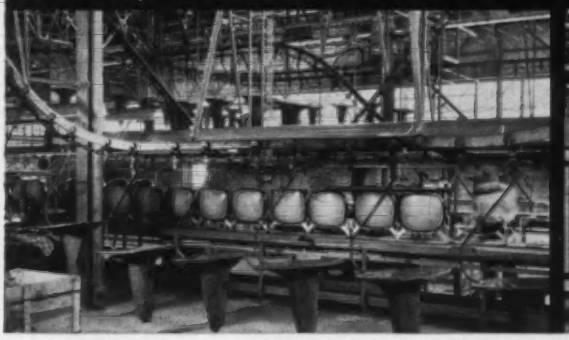
Circle 431 on Page 119

METAL WORKING—PACKAGE HANDLING—DISTRIBUTION—WAREHOUSING

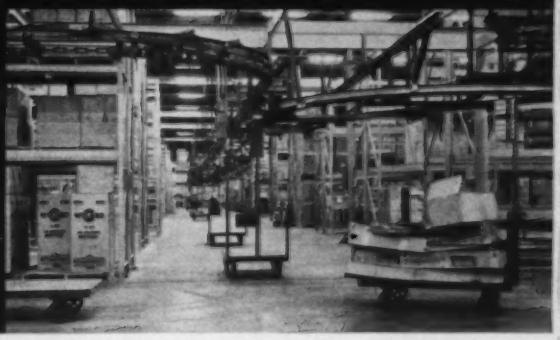
Package handling system for large auto parts distribution center. Photoelectric cells control automatic dispatch system.



Steel drums and covers are automatically moved into spray booths. Covers are brought from floor below.



A television tube conveyor on a chassis assembly line. Fast efficient flow pattern is maintained.



Overhead pullveyor in large warehouse has 18 different selector stations for automatic transfer of trucks.

Have a closer walk with Total Automation

CSI-*Farquhar's* complete approach to system handling problems can help you regain those lost profits

ASK FOR BROCHURE

A complete 56-page book shows hundreds of applications of trolley, slat, power belt, live roller, spindle and countless other conveyors. Send for your copy today!

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CONVEYOR SYSTEMS, INC.

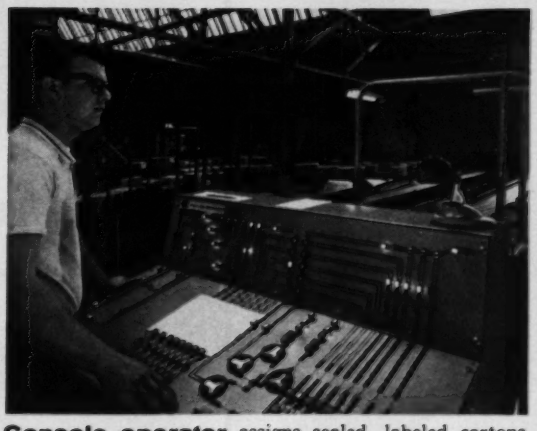
6453 Main Street
Morton Grove, Illinois (Chicago Suburb) Phone: JUniper 8-0200

CSI Farquhar CONVEYORS

THE COMPLETE LINE OF CUSTOM AND PRE-ENGINEERED CONVEYING SYSTEMS

Circle 693 on Page 119

WHAT'S NEW IN CONTROL FOR AUTOMATED CONVEYOR SYSTEMS?



Console operator assigns sealed, labeled cartons from order picking section direct to one of 23 loading spots by push-button control of diverters in this maze of conveyors leading to loading docks.

CONTROL

New order picking conveyor system solves peak demand problems

Another example of why it pays to call in the control expert early

A new Cutler-Hammer controlled conveyor system solved the problem of filling rush orders at Western Printing and Lithography, Racine, Wisconsin.

Products include text books, coloring books, games and toys—all small size, seasonal items subject to "needed yesterday" orders.

Western Printing badly needed two improvements . . . to cut costs and speed service out of its warehouse . . . flexible capacity in order-picking to meet seasonal peaks, and more speed and less confusion in the loading area.

With this new Cutler-Hammer controlled system, more than a mile of conveyors blanket the 180,000 sq. ft. order picking area. Conveyor speeds can be adjusted as can number of personnel needed to accommodate seasonal demands. In the loading area, orders are automatically routed on conveyors to the proper loading docks.

This kind of *practical automation* is a specialty with Cutler-Hammer. Provision is always planned-in for updating, but the system is never made more complex than necessary to solve the immediate problem.

FIND OUT WHAT'S NEW IN CONTROL FOR AUTOMATION

If you have a materials handling problem, chances are it's a *control* problem. It is in the techniques of control that virtually all automation advancements are being made. That's why it is so essential to call your Cutler-Hammer control expert early in your planning. You have everything to gain. There is no obligation.

Employment opportunities available for qualified engineers.

WHAT'S NEW? ASK

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C.A. Associates: Cutler-Hammer Canada, Ltd.; Cutler-Hammer Mexicana, S. A.

CONTROL

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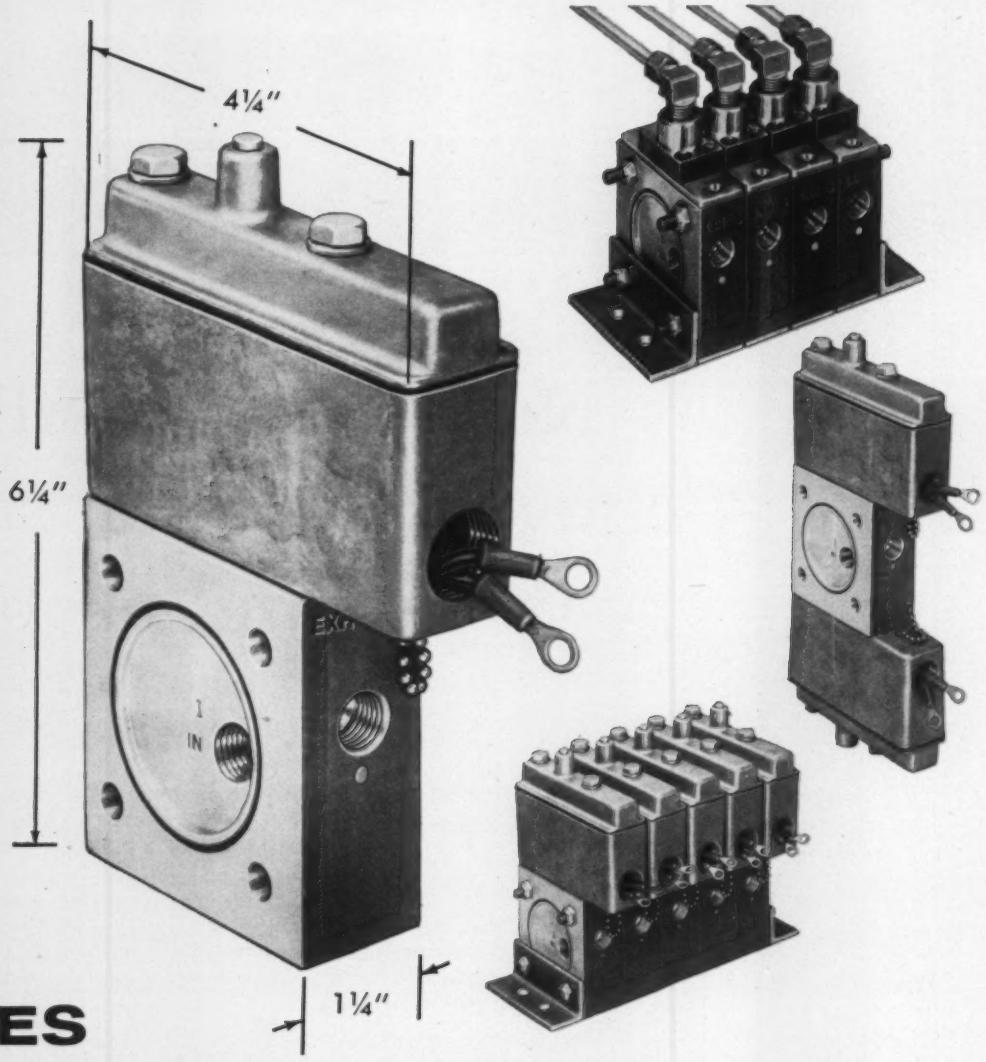
SLIM LINE

VALVES



- **minimum space • building block design**
- **maximum control flexibility**

Here's truly miniaturized, versatile precision control with surprisingly large flow capacity . . . Slim Line valves! Mount them singly to control clamping devices on jigs and fixtures. Or, bank them in manifolded groups of as many valves as you need, limited only by service and air requirements. Choose from 3- and 4-way types, for air, oil or water service, pressures to 125 psi, tapped ⅛ or ¼ in. NPT.

Where space is limited and you require maximum precision and versatility to control one or a virtually unlimited number of small or medium size cylinders, diaphragms, pilot cylinders, or similar devices . . . you need Slim Line valves. Ask your nearby Hunt representative for proof.

3048

For more information, write for Bulletin 612. Address Hunt Valve Co., Salem, Ohio, Dept. AU-1061.

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

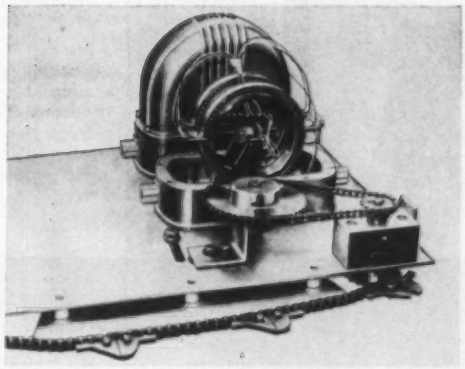
HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

Circle 695 on Page 119

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 119.



Electromechanical memory timer can be used for precise control of actuated devices installed on a conveyor system. Illustrated is a dual timer unit connected to a chain conveyor with the cover removed from one of the timers. The timer is also available as a single unit for the control of a variety of applications.

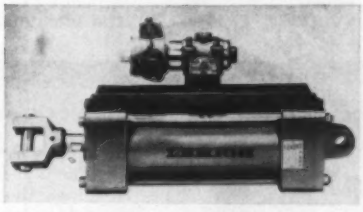
Electromechanical Memory Timer

DEVELOPED by **Binks Mfg. Co.**, 3140 Carroll Ave., Chicago 12, Ill.—memory timer is designed to control the actuation of devices installed on conveying systems, such as spray guns, transfer units, sizing and grading devices, and product sorters. It is similar in construction to a large precision ball bearing. Basic components are a drive gear; a timing ring gear with two channels similar to bearing races; 132 steel balls which accept input signals, store them, and transmit output signals; a flipper gate to control ball movement and position; and limit switches which convert the ball mechanical action into an electrical signal. A cast aluminum housing and wiring harness with multiple pin connector complete the basic elements.

In operation, the memory is driven at a speed in direct proportion to the speed of the conveyor that the timer is serving. The timer uses either a mechanical or electrical input signal (from a sensing finger or an electric eye) from the conveyor via the flipper gate arm. The gate opens on receipt of the input signal and allows a number of balls to flow from one channel to the other. The number of balls thus affected depends on the duration of the input signal. The diverted balls continue to rotate until they contact a limit switch placed on the outer perimeter of the memory timer. By closing the switch, the balls actuate electrical circuits that are used to do work on the conveyor, such as actuate a series of spray guns. The balls automatically return to their original channel. The circuit energized will stay in operation until the last of the balls have passed, at which time the limit switch will return to its normally open position. The distance the limit switch is from the flipper gate arm determines the amount of time the signal is delayed. Limit switches can be mounted at any point on the timer perimeter, providing a means for setting the correct time delay.

Being directly driven by the conveyor, the timer can stop, start, and increase or decrease speed without affecting signal input. Conveyor stoppage does not alter mechanical signal storage, and no adjustment or resetting is necessary to resume operation. The timer can be used singly, or in multiple units driven by a common drive. Any conveyor width can be accommodated.

Circle 432 on Page 119



Air Motor

Air motor has the valve mounted on top of the cylinder for instant, controlled response, greater compactness, and easier maintenance. Adaptable to many types of air motor operation, this integral valve-on-cylinder arrangement seats the valve directly on a manifold which is a solid fixture to the heads. It can be mounted in any of a number of ways including swivel, front flange, foot, or clevis. Featuring a double-acting, self-lubricating air cylinder, the air motor is available with single or double solenoids for momentary or maintained constant and in 1½, 2, 3, and 4-inch cylinder diameters. Larger diameters are also available. **Air Control Div., Lehigh Inc.**, Easton, Pa.

Circle 433 on Page 119

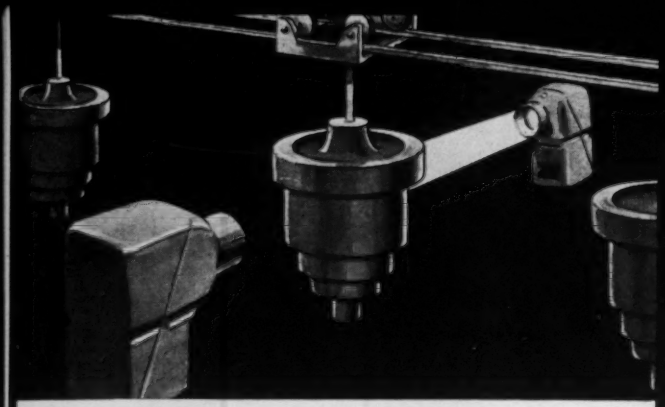
Data Readout

Series 160000 rear projection data readout features a lens system for display on almost its full viewing screen face. More message area than other readouts with the same size screen is provided for display of words, digits, special characters, and colors, alone or in combination. Multiple word messages, may be communicated in the full top-to-bottom viewing area of a readout, greatly increasing the versatility and capability of readout systems, particularly in annunciator use, while saving panel space and costs. This readout is available in assemblies as shown or individual units. **Industrial Electronic Engineers Inc.**, 5528 Vineland Ave., North Hollywood, Calif.

Circle 434 on Page 119

Position Display

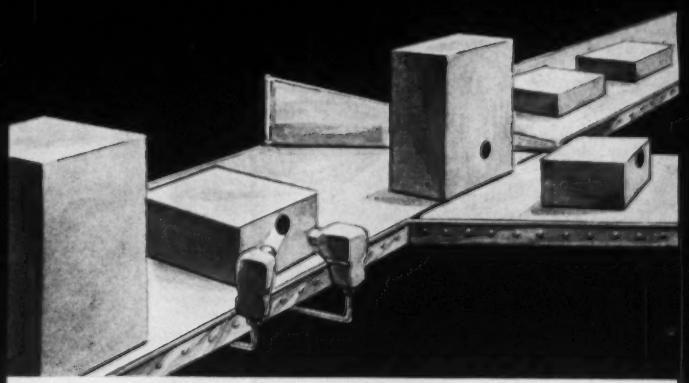
Advantages of partial automation where fully automatic numerical control of machine tools is not needed is made possible through use of this position display. This device has been designed to meet the requirements of operator controlled machines including retrofit on existing machines. It allows the operator to position the machine more rapidly and with greater accuracy, reduces operator fatigue, and avoids errors associated with



PRODUCTION COUNTING

Problem: Stepped-up production rate made it difficult to count units accurately with existing mechanical equipment.

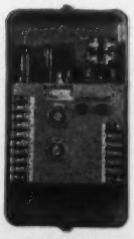
Solution: Plant Electrician installed two low-cost G-E photoelectric units connected to automatic counter. Even though production units come in bursts of over 150 per minute, this simple counting setup now tallies them swiftly and accurately.

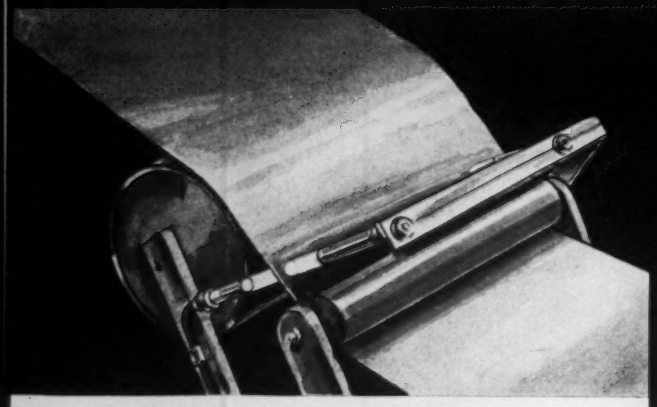


SORTING DISSIMILAR CARTONS

Problem: To automatically divert selected boxes from main conveyor to side conveyor.

Solution: Plant engineer suggested printing black circular marks on those boxes to be diverted. The absence of reflected light from the marked boxes trips the G-E photoelectric units and switches boxes to side conveyor. Unmarked boxes continue straight ahead on main conveyor.

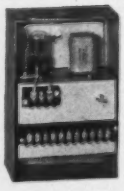


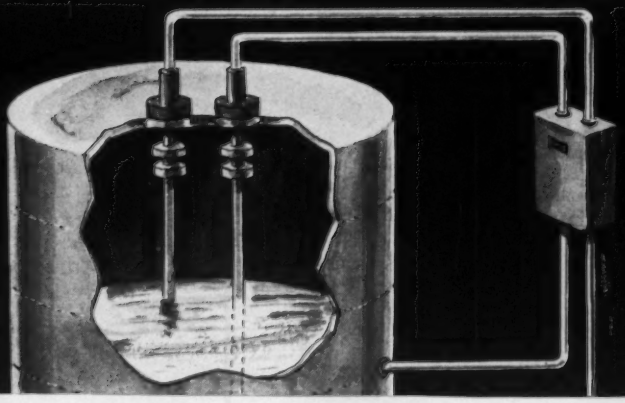


DETECTING WEB BREAKS

Problem: Paper mill experienced excess losses caused by web breaks and decided to investigate automatic detection equipment.

Solution: At G-E Application Engineer's suggestion, plant installed photoelectric web-break detectors. These units detect breaks instantly. Light penetrates through break to scanning photoelectric relay which immediately stops machine.

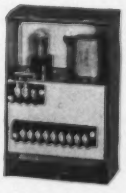




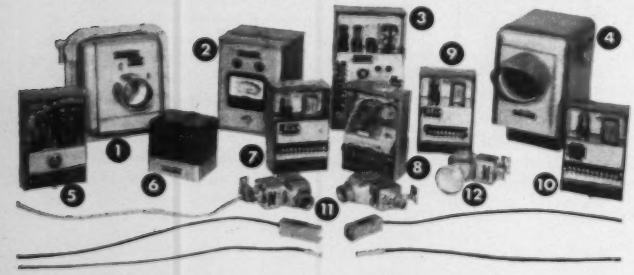
SENSING LIQUID LEVEL

Problem: Brewery planning to add 10 new vats wanted to equip them with most economical liquid level control.

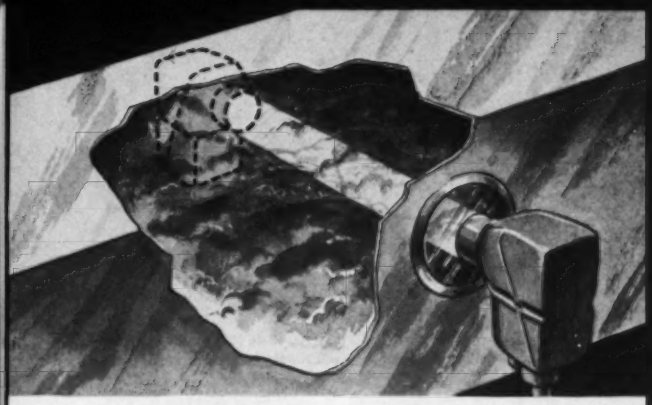
Solution: At the Plant Electrician's suggestion, General Electric resistance-sensitive relays with stainless steel probes were installed on each vat. These standard devices have only one moving part, are easy to install, and require little maintenance.



A complete line of photoelectric and electronic devices for controlling, sorting, limiting,



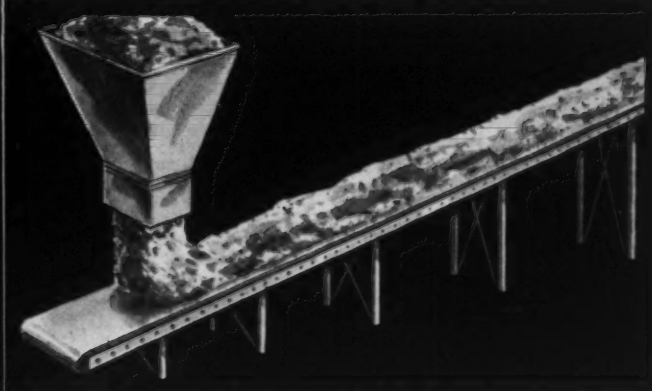
1. **Explosion-proof relay** is high-speed type in special enclosure for use in hazardous locations.
2. **Smoke density indicator** is designed for combustion control or alarm: range is adjustable from 3—100%.
3. **High-speed relay** offers .001-second sensitivity. It also includes time delay and interlock.
4. **Long-distance relay** will operate up to 2500 feet without adverse effects from ambient light.
5. **Voltage-sensitive relay** operates on input signal voltage that ranges above or below pre-selected value.
6. **General-purpose relay** is low-cost, indoor-type photoelectric relay, flexible to operate, easy to adjust.



MEASURING BURNING EFFICIENCY

Problem: To determine that furnace was operating economically, and well within local smoke ordinances.

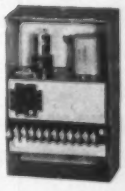
Solution: Plant Engineer installed G-E electronic smoke density indicator. In addition to performing corrective action, the indicator coupled with a strip chart recorder gives a day-by-day record of burning efficiency. It also satisfies local authorities that smoke is within prescribed limits.



AUTOMATIC CONVEYOR UNLOADING

Problem: Plant wanted to prevent reversing of loaded conveyor upon shut-down of hopper.

Solution: Plant Electrician wired simple electronic timer to hopper switch and to conveyor motor. When hopper closes, timer starts, counts off 45 seconds (long enough for conveyor to dump load completely), then stops conveyor automatically.



CONTROLS FOR AUTOMATION

6 production problems SOLVED with General Electric electronic devices

These six production problems, and hundreds like them, are today readily solved with versatile General Electric electronic devices.

Applied with ingenuity, these devices now help plants sort, divert, detect, count, and perform other operations efficiently. And new uses turn up every day. For instance, the G-E resistance-sensitive relay is often used to control liquid level, but recently, it proved equally valuable as a thread-break detector!

Cash-in on such new uses of these versatile devices by contacting your authorized G-E Distributor early. He can solve many of your problems with electronic devices from stock. And his experience is invaluable on complex applications.

And for additional information on new ways to apply G-E electronic devices, return the coupon for your free copy of GEA-6822. General Electric Co. *Specialty Control Dept., Waynesboro, Va.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

counting, and detecting applications

7. **New high-speed relay** is a low-cost unit for use with miniature or micro-miniature source and cell.
8. **Transistorized relay** features high reliability with miniature and micro-miniature source and cell.
9. **Resistance sensitive relay** operates on change in external resistance, ideal for liquid-level control.
10. **Electronic timer is** dial-set for given time; can be energized or de-energized before the timed interval.
11. **Light sources and receivers** are available in standard, miniature, and micro-miniature sizes.
12. **Self-contained relay** is low-cost, compact, tubeless photoelectric relay, ideal for limit-switch-type applications.

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FREE CATALOG

General Electric Co., Section D793-05
Schenectady 5, New York

Please send me a copy of the G-E Electronic Devices catalog, GEA-6822, with description, specifications, and pricing data on the complete line.

Name _____

Company _____

Address _____

City _____ **State** _____

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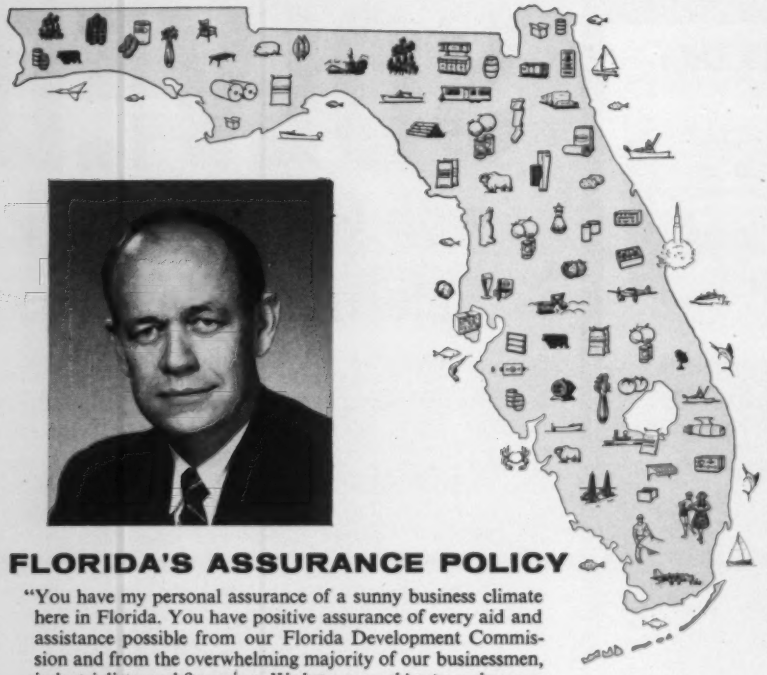

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"You have my personal assurance of a sunny business climate here in Florida. You have positive assurance of every aid and assistance possible from our Florida Development Commission and from the overwhelming majority of our businessmen, industrialists, and financiers. We have *everything* to make your large and small enterprise healthy and successful. Write, wire or phone us TODAY. The only thing better than a FLORIDA vacation is having your plant here."

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FLORIDA DEVELOPMENT COMMISSION
BOX 4118A, Tallahassee, Florida

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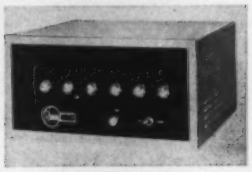
City.....Zone.....State.....

FLORIDA FOR CONVENTIONS — Write for free information on Florida's wonderful facilities for your group meeting.



reading of dials is clearly displayed. Used in conjunction with a position transducer geared to a leadscrew or precision rack, this position display is available for one, two, or more axes of motion with typical resolutions of 0.001 or 0.0001 inch and displacements up to 999.999 inches for the 0.001 inch resolution. **Electronics Div., Rheem Mfg. Co.**, 5200 W. 104th St., Los Angeles, Calif.

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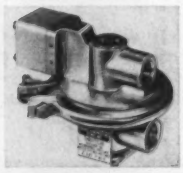

Pressure Switches

Switches which signal pressures and differential pressures in the low range of 0.25 to 16 inches of water column are designed for use in a wide variety of industrial and aircraft high pressure fluid lines, including pneumatic and hydraulic systems and process streams. These Deltadyne switches operate by means of a spring-biased diaphragm. The diaphragm senses very low pressures and at a preselected point actuates a rod which in turn sets off a switch mechanism. Desired actuation pressure is set by a direct reading dial. The units contain no mechanical linkages and are immune to damage from over-pressure up to their rated capacity of 250 psi. When used as differential pressure switches, actuation of the units is completely independent of absolute working pressure. **Pall Corp.**, Glen Cove, N. Y.

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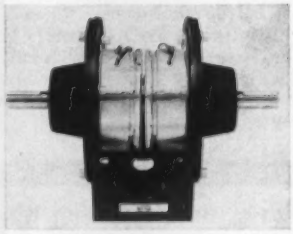


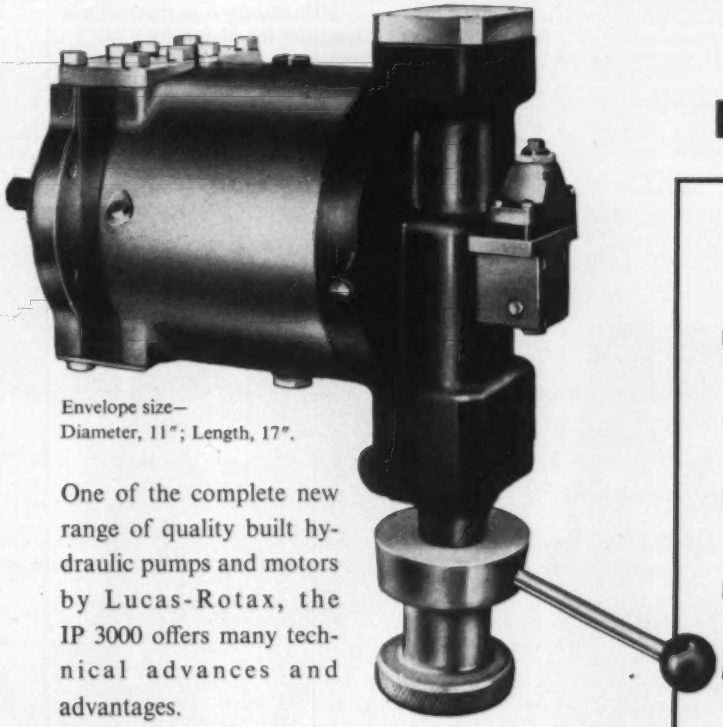
Electric Clutch-Brake

Pre-aligned clutch-brake package is designed for fractional-horsepower duty-cycle applications. An electric clutch and an electric brake are combined in a preassembled unit with input and output shaft extensions and is ready to be installed. Unit simplifies the design of new equipment or conversion of existing ma-

Unmatched in performance, quiet... the reliable

NEW IP 3000 INDUSTRIAL HYDRAULIC PUMP

by LUCAS-ROTAX



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Diameter, 11"; Length, 17".

One of the complete new range of quality built hydraulic pumps and motors by Lucas-Rotax, the IP 3000 offers many technical advances and advantages.

- **Smaller size**
- **Lower weight**
- **Variable volume**
- **Low noise level at higher operating speeds**
- **Low cost**
- **High efficiency**
- **Fitted with pressure compensator as standard equipment**

For further information, contact the agent or office nearest you today, or write for technical literature.

PUMP DETAIL

	Basic Pump Fixed Stroke
Fluid displacement (cub. ins./rev.)	13.89
Nominal working pressure (peak)	5000
(lb. per sq. in) (continuous)	3000
Nominal speed (peak)	2000
(r.p.m.) (continuous)	1800
Input h.p. at 1,000 r.p.m. and 1,000 lb. per sq. in. differential	38
Max. Torque (lb./ft.) per 1,000 lb. per sq. in. fluid pressure differential	200
Recommended Inlet Pressure (p.s.i.g.)	60
Weight (lb.) Basic Pump	128
Operating temperature	–40 to 200°F

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LUCAS-ROTAX LIMITED, TORONTO

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6010

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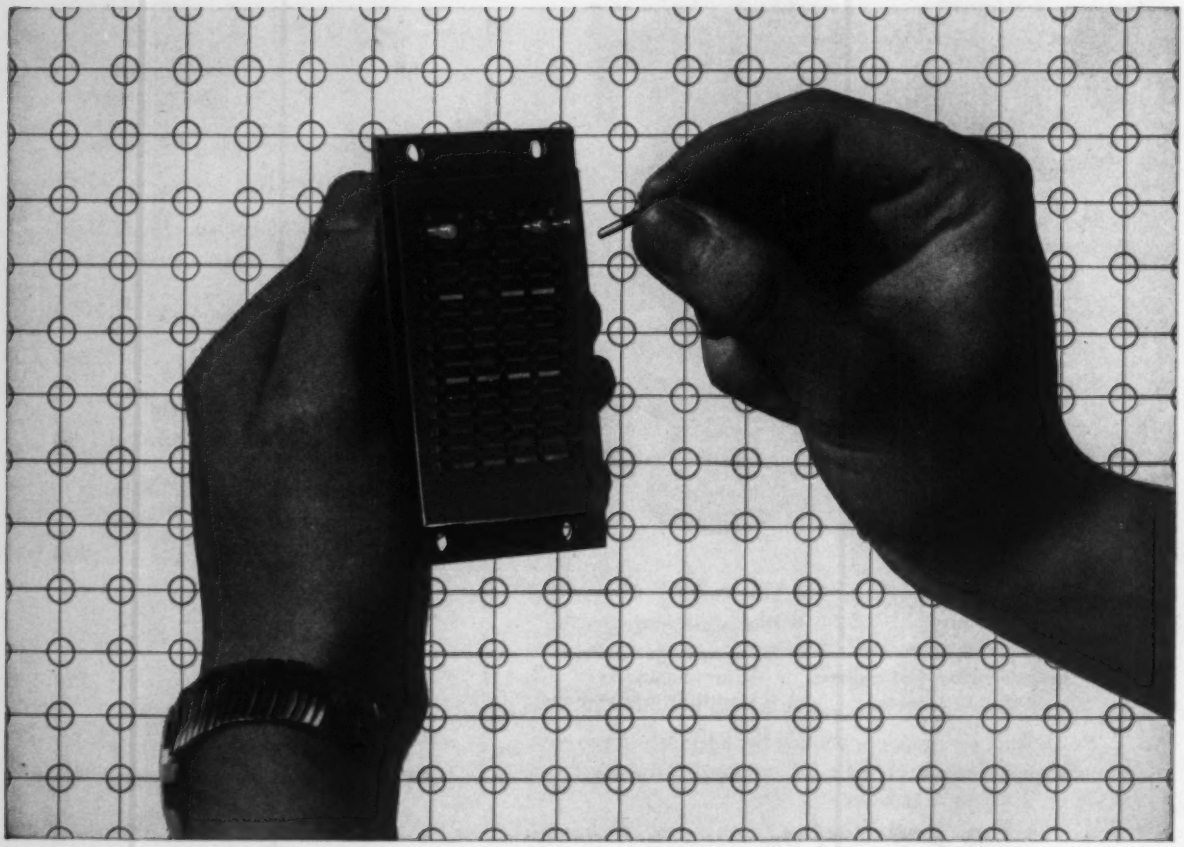
PIN POINT PROGRAMMING

AMP PINBOARDS can do a host of dry circuit switching or commoning functions . . . permit numerous matrixes in one assembly. Complicated switching functions can be accomplished by simply inserting or removing a pin.

You can use these PINBOARDS as modular building blocks for instrumentation applications, automated tooling, test equipment, data processing . . . any variety of size and grid arrangements in multiples of a basic 15 x 5 hole pattern. Contact springs can be bussed in any combination desired. And for safety, there are no exposed conducting surfaces on the rear side of the board. The conducting area of the pin is safely inside board before contact is made with mating springs.

AMP PINBOARDS are factory pre-wired to your specifications . . . with standard or special silk screen legends. Designed for simplicity . . . flexibility . . . reliability . . . with three amperes continuous current rating.

Write for complete specifications.



AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • West Germany

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AUTOMATION

reader information service

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So you will not have to clip this issue, we will gladly send you a personal copy of any article. Just fill in the page numbers and titles of the articles you desire.

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432-470—NEW COMPONENTS—*page 111*
471-510—CATALOGS & LITERATURE—*page 147*

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COMPANY _____

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ADDRESS _____

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401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851
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415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865
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427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877
428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878
429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
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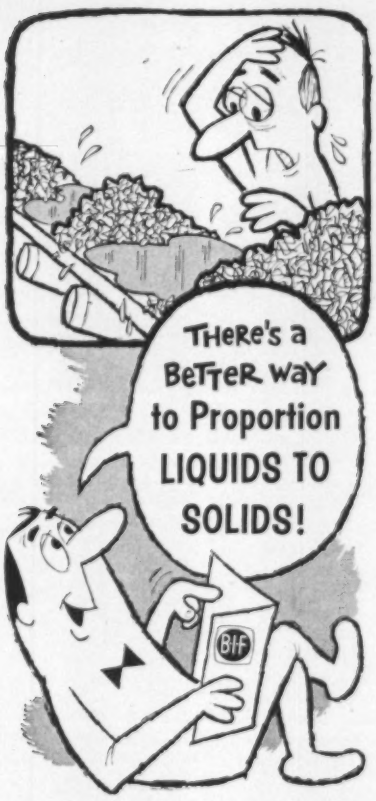
B-I-F POSITIVE CONTROL OF MATERIALS FLOW



Does your present proportioning system suffer from short range limitations? Can one unit run empty and waste ingredients . . . spoil end product? B-I-F offers a new concept in the control of liquid to solid proportioning in the combination of its continuous dry materials weigher and its closed loop metering system. Fail-safe system — automatically stops when either unit is empty . . . prevents ingredient waste and product spoilage. Forced balance weighing principle provides wide range, greater accuracy. System governed by simple gravity flow . . . operates automatically, continuously . . . features explosion-proof construction!

Free Facts

B-I-F continuous liquids-to-solids proportioning system adapts to a wide range of applications. Spray nozzle easily applied on liquid unit. Request complete details . . . write for free facts today!

B-I-F Industries

A DIVISION OF THE NEW YORK AIR BRAKE COMPANY

527 HARRIS AVENUE, PROVIDENCE 1, RHODE ISLAND

Circle 700 on Page 119

chines to automatic duty-cycle operation by eliminating the need for special mounting hardware or for precision alignment of several different components. Up to several hundred machine cycles a minute can be accomplished using the Electro-Pack drive with a continuously running electric motor or other power input. Unit is available in three sizes: Rated 10, 60, and 240 lb inches static torque for maximum shaft speeds of 10,000, 7500, and 5000 rpm respectively. **Warner Electric Brake & Clutch Co.**, Beloit, (Wis.)

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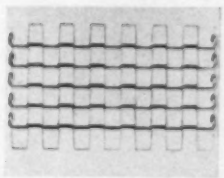

Flat Wire Belting

Flat wire belts are available in mesh sizes of 1 by 1 inch, ½ by 1 inch, and ½ by ½ inch. Any width up to 12 ft may be supplied, and mesh can be formed from carbon steel, galvanized steel, or stainless steel. Wire widths and rod diameters can be varied to meet strength requirements, although the standard width of wire is ⅜ inch. Belting can be either friction or sprocket driven. It finds application in the food process industry, the metalworking industry, the ceramic industry, and in certain phases of the chemical process industry. **Cambridge Wire Cloth Co.**, Cambridge, Md.

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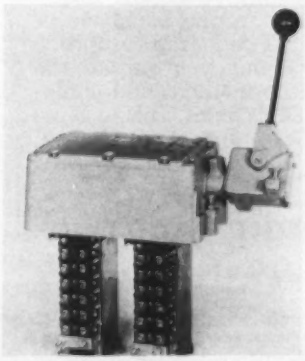
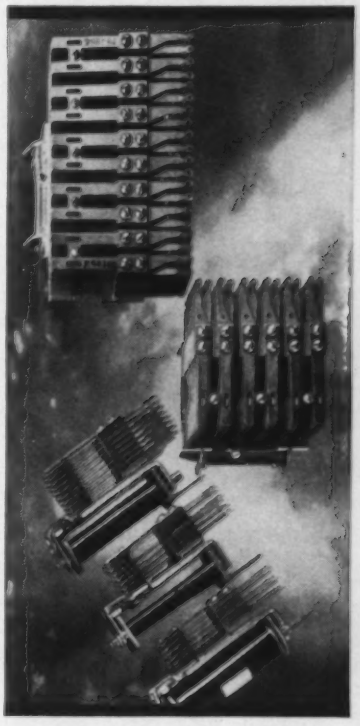


Master Switches

Line of master switches includes two types: An induction-type master switch (illustrated) which provides smooth, stepless speed control for industrial cranes, electric shovels, and other equipment using variable-speed drives; and a joy stick master switch in which a single operating handle permits simultaneous control of two motions with one hand. The induction-type switch, using the variable output of a differential transformer, eliminates wear-producing sliding parts. The single handle of the joy stick master switch can be moved into any horizontal quadrant and into any position within the quadrant. Either of these master

Stromberg-Carlson®

RELAYS



Telephone-type quality • reliability durability

TYPE A: general-purpose. Up to 20 Form "A" spring combinations.

TYPE B: gang-type. Up to 60 Form "A" spring combinations.

TYPE BB: up to 100 Form "A" springs.

TYPE C: two on one frame. Ideal where space is tight.

TYPE E: characteristics of Type A, plus universal mounting. Interchangeable with other makes.

Types A, B, and E are available in high-voltage models. Our assembly know-how is available to guide you in your specific application. If you desire, we can also provide wired mounting assemblies.

Details on request from these Stromberg-Carlson offices: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

GENERAL DYNAMICS
TELECOMMUNICATION

Circle 701 on Page 119

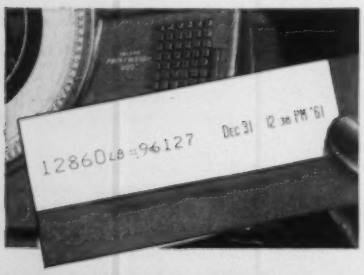
Why you should think of your scales as MONEY WEIGHING MACHINES

Cold, hard cash is the final value yardstick you must apply to every material or product that moves into, through, or out of your plant. How much does it cost? How much does it save? How much profit does it produce? In the last analysis, the answer always comes up in dollars and cents.

With dollars at stake, the *right* Toledo Scale at each weighing point is of the *utmost importance* . . . the backbone of control your needs demand. Your Toledo representative will take a personal interest in helping you get all the benefits provided by advanced Toledo methods and equipment. Write today. Toledo Scale, Division of Toledo Scale Corporation, Toledo 12, Ohio. *(Toledo Scale Company of Canada, Ltd., Windsor, Ontario.)*

TOLEDO PRINTWEIGH® "400"

provides complete printed weight records



Prints where you wish on full 8½" x 11" forms, or on tickets or strips. Prints full figures, even when unit weights are used. Positive weight identification, with selective numbering, weight symbols, or consecutive numbering. Also prints time and date, if required. Weight data may be transmitted electrically to remote adding or other office machines. Ask for Bulletin 2017.

SERVICE Factory-Trained 340 Cities

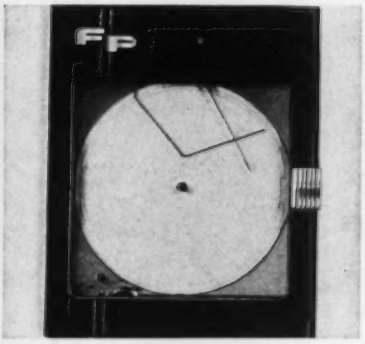
TOLEDO®

Headquarters for Weighing Systems

Circle 702 on Page 119

switches can be desk, console, or pedestal mounted. General Electric Co., Schenectady 5, N. Y.

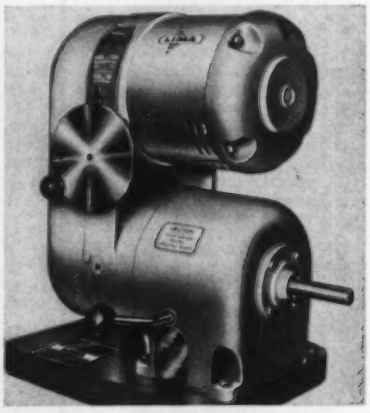
Circle 439 on Page 119



Transistorized Recorder

Recorder has fully transistorized circuits, positive drive action, a built-in voltmeter, and a direct reading range dial. It provides a stable, noise-free magnetic flowmeter ac potentiometer. The entire unit is built on a single removable chassis, and amplifiers, preamplifiers, and a range network are mounted on plug-in cards that can be easily removed and replaced. The recorder features an automatic quadrature rejection which requires fewer adjustments while providing a high level of stability. Other features include: Easy access to controls; all adjustments are on front of the case; positive *On* indication; electronic smoothing; and a built-in dashpot. Fischer & Porter Co., 862 Jacksonville Rd., Warminster, Pa.

Circle 440 on Page 119



Variable Speed Drive

Speeds between 180 and 1800 rpm are obtainable from this variable speed drive when an 1800-rpm motor is incorporated. Using a 1200-rpm motor all speeds between 120 and 1200 are available. Either drip-proof or totally enclosed fancooled units can be furnished in ½, ¾, or 1 hp. A simple control wheel regulates the output shaft to the desired rpm. A pointer indicates on a calibrated speed plate the exact rpm at which the output shaft is

A NEW ADDITION TO THE SONAC *LINE*

POSITIVE ULTRASONIC LEVEL CONTROL

The components of Sonac (sensor actual Size)

Now, two new ultrasonic sensors, especially for level control have been added to the Delavan line of SONAC sensing and switching devices.

The single sensor system is recommended for liquid level control and the double sensor system for dry level control.

Control is maintained by installing the SONAC sensor through the wall of the vat, bin or hopper. When the oscillation on the face of the sensor is dampened or impeded by the material being sensed, the signal to the control unit changes, activating a relay.

FIG. 1—LIQUID LEVEL (One Sensor)

FIG. 2—DRY LEVEL (Two Sensors)

For level control, SONAC is accurate to .005" and has a response time of 25 milliseconds. Performance of the sensor does not deteriorate with age.

The level control uses to which SONAC can be applied are virtually unlimited. It is not affected by the viscosity*, specific gravity, conductivity, or capacitance of the material being sensed. Temperature or pressure changes of the material do not alter its performance. False signals are eliminated because SONAC may be adjusted so as not to sense steam, foam, or vapors.

*Viscosity may affect response time.

Canadian Representative:

KNOWLES & FOSTER (North America) Ltd.

708 Terminal Bldg., Toronto 1, Ontario, Canada

SONAC is extremely rugged. Sensors are type 304 stainless steel. The electronic components in the sensors are hermetically sealed and will withstand pressures to 2000 psi and temperatures from −425° F. to +450° F. They are immune to shock, vibration or mechanical damage.

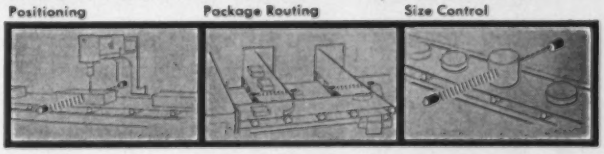
The control is a compact unit 5" x 5" x 5" and features transistor circuitry. Power consumption is one watt and the unit will operate in temperature ranges from 40° F. to 135° F.

Here's how SONAC can be used for sensing and switching applications other than level control.

Automatic Counting Positioning

Door Control Package Routing

Overheight Signal Size Control



There are dozens of applications for SONAC *single and double sensor units. Let it go to work for you now, write:*

DELAVAN Manufacturing Company

WEST DES MOINES • IOWA

A

Circle 703 on Page 119

MARK *delicate* PARTS

WITHOUT MARRING OR DISTORTING SURFACES . . .

- CLEARLY
- PERMANENTLY
- AT LESS COST

MATTHEWS

AIRGRIT

MARKING MACHINE

Matthews Airgrit eliminates many marking problems. It may be the answer to yours.

Through inexpensive molded rubber masks, it will "blast-etch" trademarks, names or codes with lettering as small as .055" within a fraction of a second. Masks have surprisingly long life for economical marking.

Self contained unit needs only air source and electrical outlet for easy installation. Simple to operate, no special training required.

Write for Bulletins C-25, C-26 or forward part for sample marking

MATTHEWS MARKING PRODUCTS

JAS. H. MATTHEWS & CO.

3945 FORBES AVENUE • PITTSBURGH 13, PENNA.

Circle 704 on Page 119

turning. The incorporation of a four-speed transmission as a component of the drive results in three times greater torque at low speed than in any comparable friction type unit. **Lima Electric Motor Co. Inc.**, Dept. 286, Lima, Ohio.

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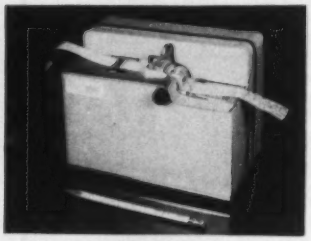

Paper Tape Punch

Motorless, direct-drive paper tape punch will perforate any 5, 6, 7, or 8 hole tape at rates up to 20 characters per second. Typical applications include: Business data processing, communications, process control, machine tool control, automatic testing and checkout, and telemetry data reduction. Model P-1002 is available in three package styles—in a cabinet for bench or desk use, without a back cover for OEM mounting, and with a 19-inch front panel for mounting in a standard relay rack. **Invac Corp.**, 14 Huron Drive, Natick, Mass.

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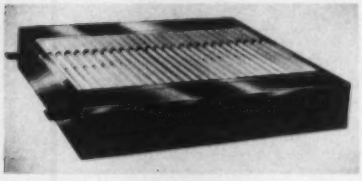
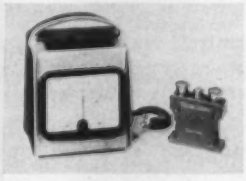


Quartz Lamp Unit

New techniques, using fluid cooling, make it possible to construct very compact quartz lamp ovens and furnaces that have extremely high heat transfer rates. In addition to precision control of equipment with no contamination during processing, almost any shape of equipment may be fabricated to meet requirements for temperatures up to 3000 F. **Fostoria Corp.**, Box 100, Fostoria, Ohio.

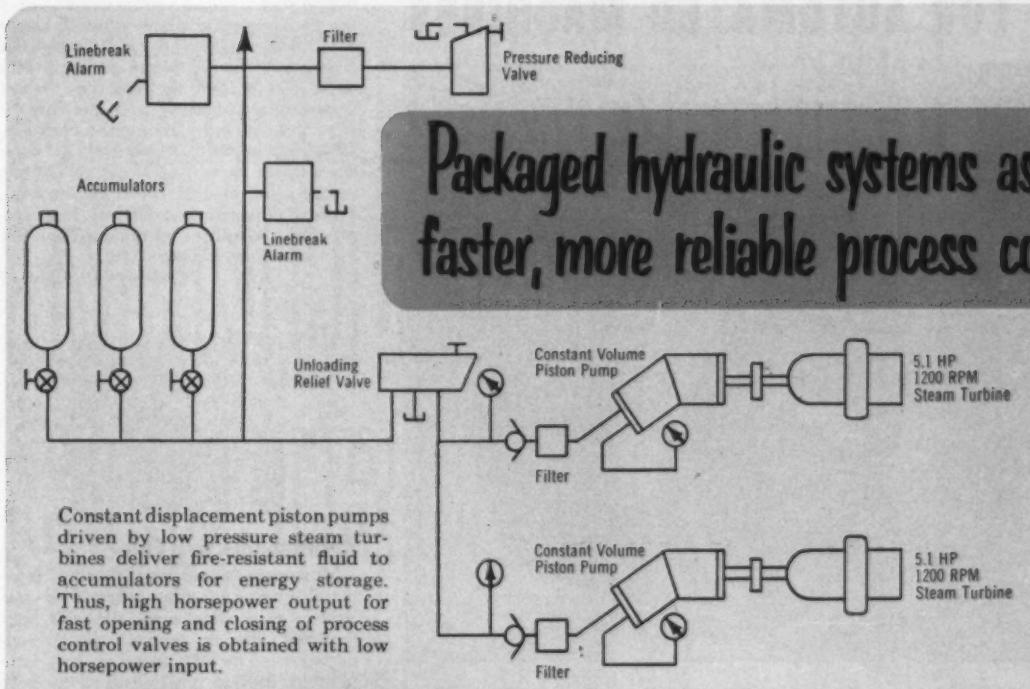
Circle 443 on Page 119



Electronic Level

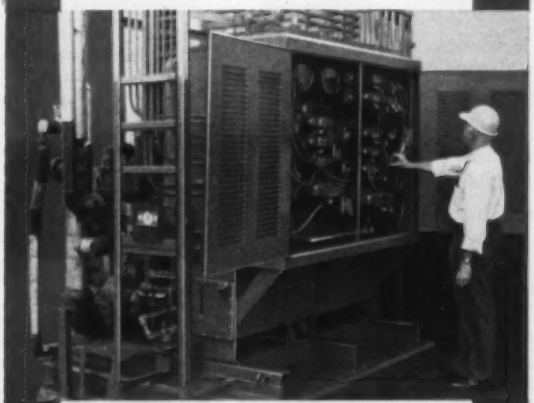
In the Talyvel electronic level the standard bubble is replaced by a pendulum and a pair of variable inductance transducers which provide an electrical displacement signal. This signal is ampli-

Packaged hydraulic systems assure faster, more reliable process control



Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

Vickers complete packaged systems are ready to go into service upon arrival in your plant, since they are thoroughly pretested before shipment. They are properly designed and built to give maximum service life with little downtime, thus helping to keep your plant on stream.

Get more information on the job being done by Vickers packaged hydraulic systems in chemical, petrochemical, petroleum refining, and other processing industries by writing today for Bulletin I5802, "Packaged Hydraulic Systems for Process Control."

VICKERS INCORPORATED
DIVISION SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1536 • Detroit 32, Michigan

9138

Circle 705 on Page 119

IDEAL FOR AUTOMATED MACHINES

Maxitorq
ELECTRIC
CLUTCHES and BRAKES

Incorporating advanced design principles proved through years of service, the MAXITORQ Electric Clutch is well adapted to all types of machine drives. Simple in design . . . built to machine tool standards . . . requires no adjustments, can be used either as a clutch or brake. Disc separators not only separate discs, but also break up residual magnetism and result in extremely fast, positive action with no drag or heating in neutral. There are few moving parts. Electrical operating unit remains stationary — hence, no troublesome slip rings, brushes, or difficult wiring problems. Operation is on standard 100 V d.c. Other voltages on special order.

If you have a clutch or brake application where you are looking for NEW and IMPROVED performance, we invite you to bring the problem to us. Phone, wire, or write Dept. AT for Bulletin No. 90.

SPECIAL FEATURES

- Engaged entirely by magnetic flux.
- Operate either on-off or by varying voltage for torque control.
- NO troublesome slip rings or brushes.
- NO levers, cams, or other highly stressed mechanical parts.
- Operation is not dependent upon rotation.
- Finished complete, assembled, and ready to install on shaft.

THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONN.

ICJ61

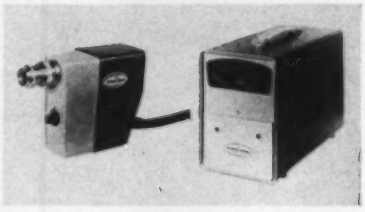
fied to feed a center-zero meter. The level can be mounted in places where it would be difficult to read a block level. The meter unit can be placed at a distance up to 300 ft from the level unit, where it can be conveniently seen and read. It is battery operated. The transistorized amplifier and meter is scaled both in angular measure as well as linear to indicate precisely the amount of tilt of the level. **Engis Equipment Co., Div. of Engineering and Scientific Instrumentation,** 431 S. Dearborn St., Chicago 5, Ill.

Circle 444 on Page 119

Photoconductive Cell

Miniature photoconductive cell is capable of measuring either tungsten or daylight over a wide range of color temperatures through variation in its conductance. The "I" series of cells contains six distinct types designed for both normal and low impedance transistor type applications in both side and end view hermetically sealed configurations. Typical applications for the cells are television picture tube brightness and contrast control, photographic exposure meters without correction filters, and reliable streetlight switches. **Clairex Corp.,** Eight W. 30th St., New York, N. Y.

Circle 445 on Page 119



Pyrometer

Pyro-650 optical brightness pyrometer makes possible continuous recording and controlling of high temperatures in a range from 1200 to over 7000 F. It has many uses in industries such as metals, cement, ceramics, glass, refractory materials, and others where operations are carried out at high temperatures. This device is ideal for those applications where thermocouples or total radiation pyrometers cannot be used. **Instrument Development Laboratories Inc.,** 67 Mechanic St., Attleboro, Mass

Circle 446 on Page 119

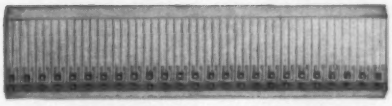
Rotary Limit Switches

Line of low ratio, geared-down and geared-up rotary limit switches has gear coupled potentiometer options. Illustrated is a four circuit unit with a 1:1 ratio for the cams and a 1:3 ratio for the potenti-

Circle 706 on Page 119

3 VITAL FACTORS IN NUMERICAL CONTROL!

1 - ACCURATE MEASUREMENT



The linear transducers in the Sperry Control provide highly accurate measurement unaffected by age or wear. Made of a special glass/mica compound, these transducers have a coefficient of expansion similar to steel and consequently introduce no measurement error within the machine mass due to temperature changes.

2 - PRECISE CONTROL OF POWER DRIVE

The exclusive Sperry electro-hydraulic Servo Valve provides precise control of hydraulic cylinders or motors. The Sperry valve's unique construction eliminates linkages, springs and "dither".

3 - RAPID, RELIABLE DATA REDUCTION

Rapid, reliable data reduction is obtained through the use of the Sperry Tape Reader. This reader uses low pressure airflow to read punched tape. The air pressure also keeps the reader head and tape clean, thus avoiding reading errors due to dirt contamination. The Sperry block reader can read ten, twenty line blocks per second.

There is a fourth factor that is vital to any numerical control installation and that is *Systems Engineering*. Sperry's staff of servo systems engineers, strategically located across the country, is at your disposal to ensure the success of your particular application.

For more systems application data for your particular machine or process, write to:

SPERRY

SPERRY GYROSCOPE COMPANY OF CANADA, LTD.
P.O. Box 710, Montreal 3, Que.

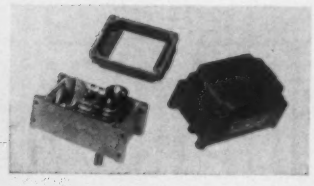
Circle 707 on Page 119

DISPLAY NUMBERS, WORDS, COLOR, and SYMBOLS

Ideal for computers, electrical and electronic test equipment, control systems, and annunciation boards. Price complete from $18.00. Write today for complete detailed specifications and quantity prices.

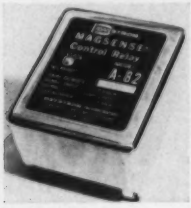
INDUSTRIAL ELECTRONIC ENGINEERS, Inc.
5528 Vineland Ave., North Hollywood, Calif.

Circle 708 on Page 119



ometer. A typical application would be controlling end limits of a motor operated valve with the potentiometer providing continuous valve position indication in a remote location. Units are available having 2 through 4 S.P.D.T. or 2 D.P.D.T. switches with gear ratios of 1:1, 1:2, 1:3, 3:1, and 2:1. Potentiometer coupling is available with the 1:1 ratio unit and can be geared at 1:1, 1:2, and 1:3. **Gemco Electric Co.**, 25685 W. Eight Mile Rd., Detroit 40, Mich.

Circle 447 on Page 119



Control Relay

Solid-state control relay has high sensitivity to low level currents with resolution of one microampere. The switch's ability to withstand adverse environmental conditions makes it particularly valuable for military ground support equipment and for industrial use in which high reliability and flexibility are important. Converter's single set point is easily adjustable with accuracy and repeatability of one microampere over full input range. The signal input range from 0 to 100 microamperes may be extended under special conditions with no loss in resolution. **Control Systems Div., Daystrom Inc.**, 4455 Miramar Rd., La Jolla, Calif.

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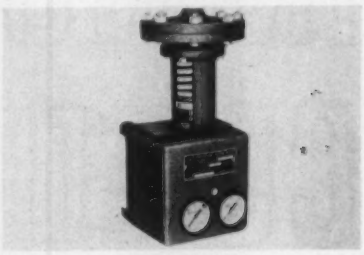
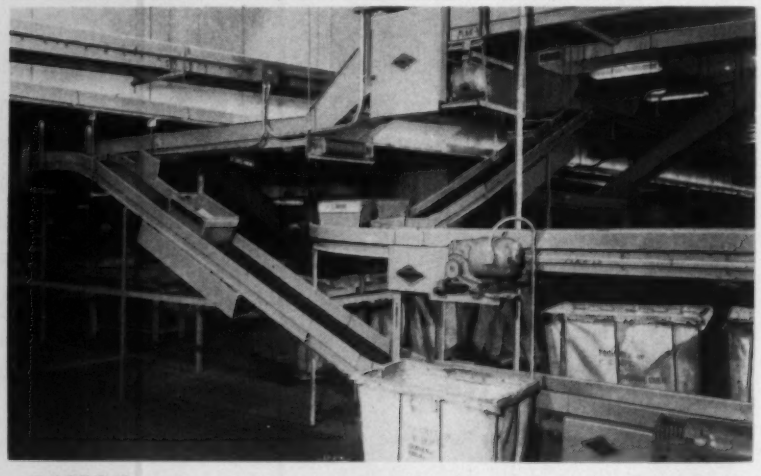


Pressure Controller

Unit incorporates the features of stability and ruggedness with single knob proportional band adjustment to tune pilot response to system requirements. The easy matching of this proportional bank controller to the ideal response required in a particular pressure control system overcomes cycling and unstable control tendencies caused by time lags and system inertia. The controller can be used in corrosive service or corrosive atmospheres for the precise and stable control of steam, gas, or liquids. It is ideal for applications where nonsparking control equipment is required. Unit is available from stock in both direct acting (Type PDAP) and reverse acting (Type PRAP) models. **Leslie Co.**, 144B Delafield Ave., Lyndhurst, N. J.

Circle 449 on Page 119



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Here is but one station in the complete, fully automated conveying system developed by A-F for smooth, efficient mail flow throughout this modern post office.

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A-F *ENGINEERED* CONVEYING SYSTEMS
Also Pre-Engineered Conveyor Components
Wheel, Trolley, Roller, Belt.

THE ALVEY-FERGUSON CO., 172 Disney St., Cincinnati 9, Ohio

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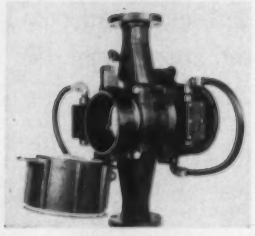

Turbidity Transmitter

Instrument measures the percentage of solids in a liquid and transmits this measurement to recording and/or indicating equipment at remote stations up to 500 ft distant. Designated as Type UT1100A, the unit includes a flow chamber, a light source, and a bolometer and can be calibrated for any convenient range and units. The turbidity transmitter operates at pressures up to 60 psig and temperatures up to 250 F. It responds to changes of 0.1 per cent or less of full scale. A receiver-recorder can be used with this device to provide con-

National Acme's SL2X limit switch

doubly certified

explosion proof

SWITCH SHOWN ACTUAL SIZE

Specify National Acme's SL2X . . . and eliminate limit switching problems under explosive conditions. Tested and certified "explosion-proof" by both Underwriters' Laboratories and the Bureau of Mines, the SL2X is specifically designed for use in the mining, chemical, process industries . . . anywhere explosions cannot be tolerated. Latest of National Acme's dependable SL2 "Machine Life" Limit Switches, the SL2X also offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (12½ lbs. at 1½" radius). Get all the details on this new standard of limit switching dependability and safety. Call, write or wire.

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Circle 710 on Page 119

ELECTRIC INFRARED PROCESSING EQUIPMENT NOW PROVIDES TEMPERATURES FROM 1° TO 3000° F. FOR ANY INDUSTRIAL APPLICATION WHERE HEAT IS REQUIRED

The Fostoria Infrared process is partly responsible for the quality built into the products you see here. Its versatility provides economies unheard of in convection heating equipment. Its speed breaks bottlenecks in production techniques. Its flexibility allows adjustment to new conditions with a minimum of effort. If you use heat in your manufacturing process, make a note to check with Fostoria about how to improve product quality with this time-saving, money-saving, labor-saving elecric infrared equipment.

For temperature requirements under 900° F. send for folder "Applications Unlimited."

For temperature requirements from 900° to 3000° F. send for "Breakthrough" folder.

BREAK THROUGH!

FOSTORIA

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MANUFACTURERS OF ENGINEERED RADIANT ENERGY EQUIPMENT AND CRITICAL WORK AREA LIGHTING

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tinuous remote chart records of the measured variable. **Bailey Meter Co.**, 1050 Ivanhoe Rd., Cleveland 10, Ohio.

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Flow Divider Valve

Model 131089 priority-type flow divider valve simplifies control of hydraulic systems requiring a variable rate of fluid flow from one fixed displacement pump. Principal design feature of this valve is a lever-controlled orifice that can be adjusted to provide optimum rate of flow to meet specific conditions. Positively locked stops provide 10 calibrated rates up to 60 gpm in addition to the shut-off position. The valve can be linked with additional units in series or parallel circuits to operate multiple motors and actuators in the same system from one pump. This valve can be controlled directly or from a remote location by an extension shaft. It handles all standard mineral type hydraulic fluids at temperatures up to 250F. **Hydraulic Electronic Div., Fawick Corp.**, 9919 Clinton Rd., Cleveland 11, Ohio.

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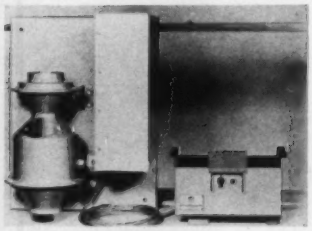

Dry-Flow Meter

Device has been developed for measuring, by weight, the flow of almost any dry material. The smallest Model IPI Dry-Flow meter accurately measures flows as small as 5 lb per minute. Seven models for 2 to 14-inch spout sizes are available in the Model A series. The largest unit of the series is capable of measuring up to 3500 lb per minute. Materials successfully measured with an accuracy of ±1 per cent include carbon black, pelletized products, and wood chips. Unit is easily installed in existing piping, without major alterations. **Industrial Powertronix Inc.**, 621 S. W. Morrison St., Portland, Oreg.

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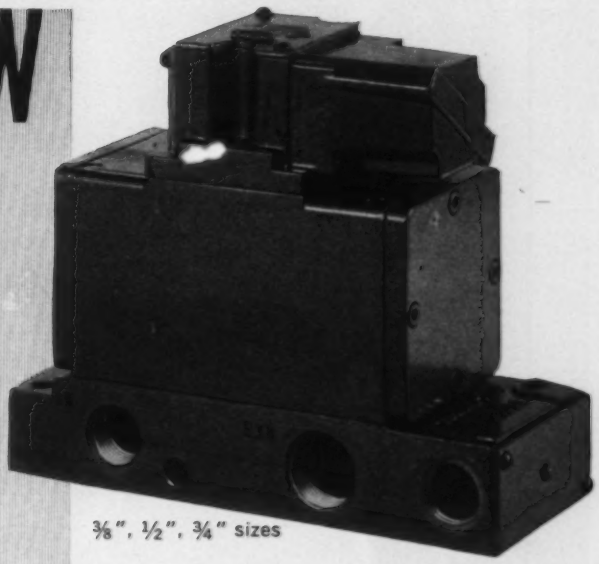
Switching System

Noncontact sensing and switching system using ultrasonic energy for its beam will sense liquids, solids, ferrous or non-

NEW HANNIFIN "HUSTLER" VALVES GIVE YOU SPEED, SURENESS & GOOD SERVICE



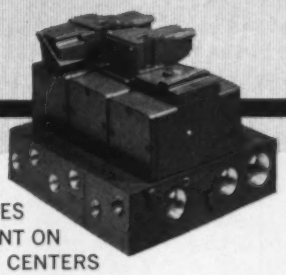
⅜", ½", ¾" sizes

ALL the features you want in 4-way, pilot-operated air control

HOW FAST? So fast it fills 12 cu. in. test chambers from 0 to 90 psi in 0.029 seconds. Larger, 100 cu. in. chambers fill in 0.075 seconds. Valve itself has been cycled on test over 3,000 times a minute. We know of no faster valve.

HOW SURE? Valve will operate on severely restricted air supplies and at pressures down to 15 psi, thanks to a reserve volume of pilot air, maintained at maximum line pressure in a self-restoring accumulator chamber (patent applied for). Low-wattage, nylon encapsulated, plug-in solenoids are guaranteed for life against burnout. New "Comb-O-Seals"—one-piece, pressure-energized—seal positively, cannot be improperly assembled. Any of today's varied air line lubricants can be used. Both pilot valve and main valves operate on poppet principle, cannot stick in dirty air.

HOW GOOD? Good for millions of leak-proof cycles! All-aluminum, die cast construction gives you light weight, assures clean, smooth air passages. Base mounting—all connections, air and electrical, are permanently made to the base. Quick plug-in feature—entire operating unit "plugs" into base; remove two screws and it lifts off easily and quickly. Locking manual over-ride is standard on all solenoid models. All models fully meet J.I.C. standards.



VALVES MOUNT ON 3⅛" CENTERS

ADD-A-FOLD BASES (optional) permit joining a number of valves together, with one supply, one exhaust, one gallery for electrical connections.

You can have either maintained or momentary contact electrical actuation—or remote pressure actuation. Valve is available in ⅜", ½" and ¾" pipe sizes. Write for new Bulletin 0611-B1.

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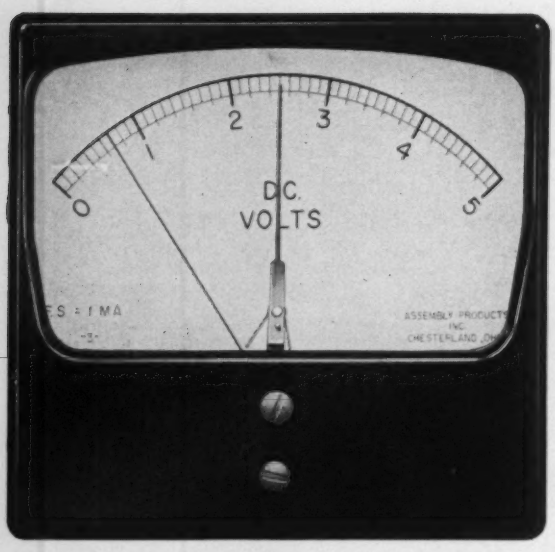
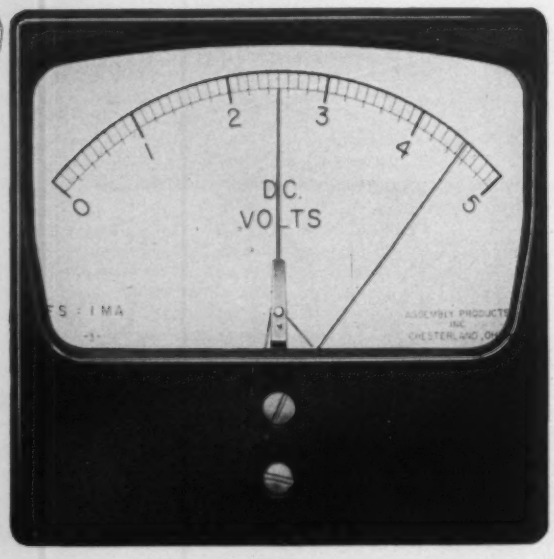


NEWS! API NOW HAS A CONTINUOUS READING METER-RELAY. No signal-sampling interrupters necessary. The CRMR indicates continuously, controls continuously, resets automatically. Built around an unrestrained D'Arsonval movement, it will monitor and control any variable translatable to analogous voltage or current values. Sensitive enough to operate on inputs as small as 5 millivolts or 10 microamps full scale, it will accept low-level signals without amplification. Compact as a panel meter, it needs only a power supply and load relay (both of which API can furnish) to make a complete little control system. Or, you can build it into an equipment control network. Bulletin S-2-1 will give you details on operation, along with specifications and price information. A copy is yours for the asking.

ASSEMBLY PRODUCTS, INC.
CHESTERLAND 27, OHIO



SA 2376

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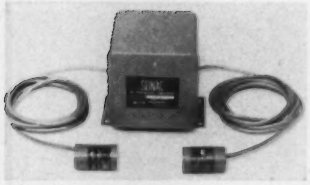

ferrous metals, opaque or transparent objects. The Sonac system consists of an amplifier, containing a power supply and control relay, and one or two sensors which are not affected by ambient light, dust, mist, or normal buildup of residual solids on the face of the acoustic lens. This system can be used for counting, sorting, liquid level, and solid level control with sensing set up on a straight line, reflective, or through flexible tubing paths. **Electro Sonics Div., Delavan Mfg. Co.**, West Des Moines, Iowa.

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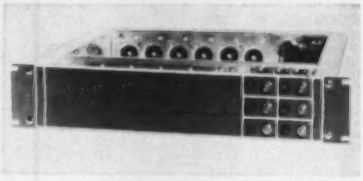

Computer Building Block

Fixed program analog computer building block is designed to be incorporated as original equipment for machine tool and process control instrumentation and simulation. The unit accommodates 6 pairs of plug-in amplifiers (of a variety of types) to provide six channels of high gain drift-stabilized analog computation. Programming for computing control or process and system simulation is accomplished internally by permanent wiring of circuit components on a phenolic terminal board. Input is +300 v dc, −300 v dc, 115 v ac 60 cycles. **Embree Electronics Corp.**, 993 Farmington Ave., West Hartford 7, Conn.

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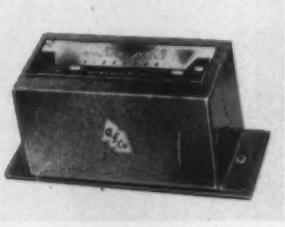
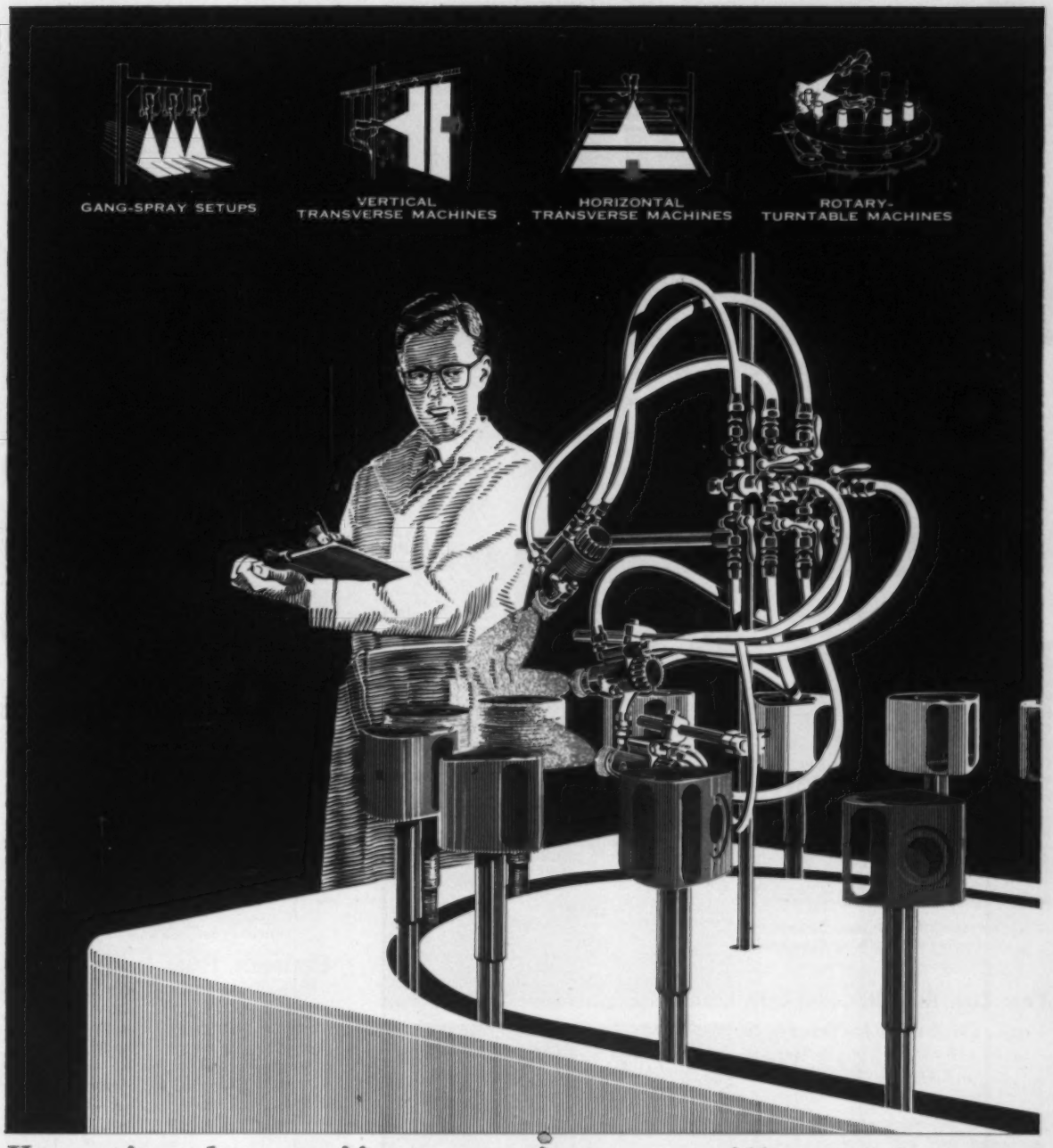


Electric Vibrator

Designed to move hard-to-flow materials, electric vibrator keeps small parts, granular or bulk materials moving freely in hoppers, tracks, bins, and chutes. Other applications include bulk feeding, parts jogging, screening, and packing. Its use eliminates sticking, arching, and bridging. Entirely portable, the small box-like Vibra Pak housing is attached at the point where vibration is desired. Plugged- into 110-



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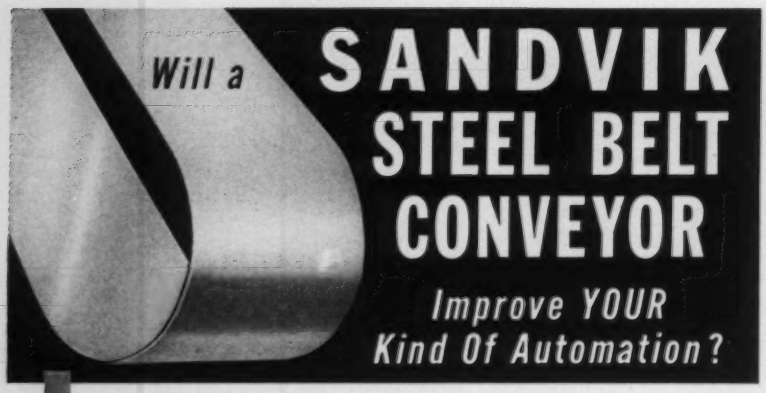
Many manufacturers have benefited from the uniform and precisely controlled application of automatic spray. DeVilbiss makes it easy to find out whether automatic spray is practical and economical for you, *before you buy*. Here's how:

Utilizing your own coating formulation, we'll give samples of your products trial production runs on standard automatic machines, duplicating your in-plant conditions as closely as possible. The results will let you know whether or not automatic spray will pay off for you. Our report tells you the most economical production rates and recommends which type of automatic machine will give you the best job at lowest possible cost. No charge for this service.

More likely than not, automatic spray *can* boost your finishing rates and cut your material consumption. If you're interested, let us know. We'll take it from there. The DeVilbiss Company, Toledo 1, Ohio. Also Barrie, Ontario; London, England; São Paulo, Brazil. Branch offices in principal cities.

FOR TOTAL SERVICE, CALL
DEVILBISS

Circle 714 on Page 119



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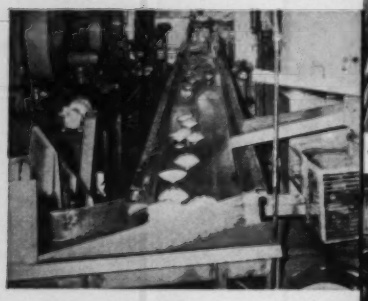
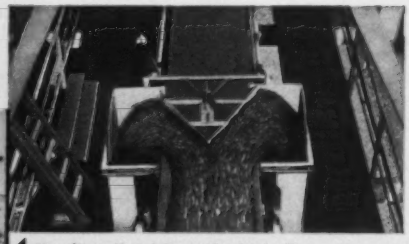
- *A strong, impermeable conveying surface of solid steel that —*
- *Resists oil, heat, impact and abrasion*
- *Lets products ride or slide, simplifying live backlogging and automatic discharge.*

For more information without obligation write or phone your nearest Sandvik office.

Handling Bulk Materials



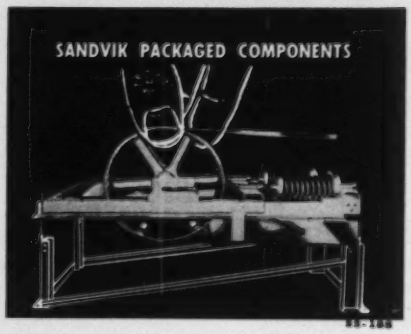


Handling Metal Parts Up An Incline

Sandvik Water-Bed Conveyors Cooling & Solidifying Chemicals

You Can Buy It Complete Or Build It Yourself With

In addition to complete, custom-engineered steel belt conveyors, Sandvik supplies conveyor components in packaged unit assemblies. For example, from Sandvik you can buy the tension end assembly, drive end assembly, steel belt, idlers and discharge devices and Sandvik will provide engineering assistance to help you build or convert to a steel belt conveyor.



SANDVIK STEEL, INC.

SANDVIK STEEL BELT CONVEYORS

Steel Belt Conveyor Department
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Sandvik Canadian Ltd., P. O. Drawer 1335, Station O. Montreal 9, P. Q.
Manufacturers of Steel Belt Conveyors for Over 40 Years.

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volt, ac power, the unit initiates a pulsating motion at the rate of 3600 vibrations per minute. Vibrator is available in two series (EV and PEV). There are three models in each series. Series EV has a dual range for greater power applications, either one available by merely flicking a switch from off to high or low. **Automatic Feeder Co.**, 4752 W. Washington Blvd., Chicago 44, Ill.

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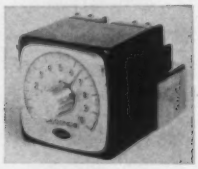
Solenoid Valve

Two-way high pressure solenoid valve is designed for applications where the valve is opened when its solenoid is de-energized. It is especially suited for hydraulic applications. Valve operates at pressures to 1000 psi air, and 850 psi water and light oil. It is supplied in ½ inch N.P.T. pipe size. General purpose, watertight, or explosion-proof solenoid enclosures are available with the valve. **Automatic Switch Co.**, Sales Promotion Dept., Florham Park, N. J.

Circle 456 on Page 119



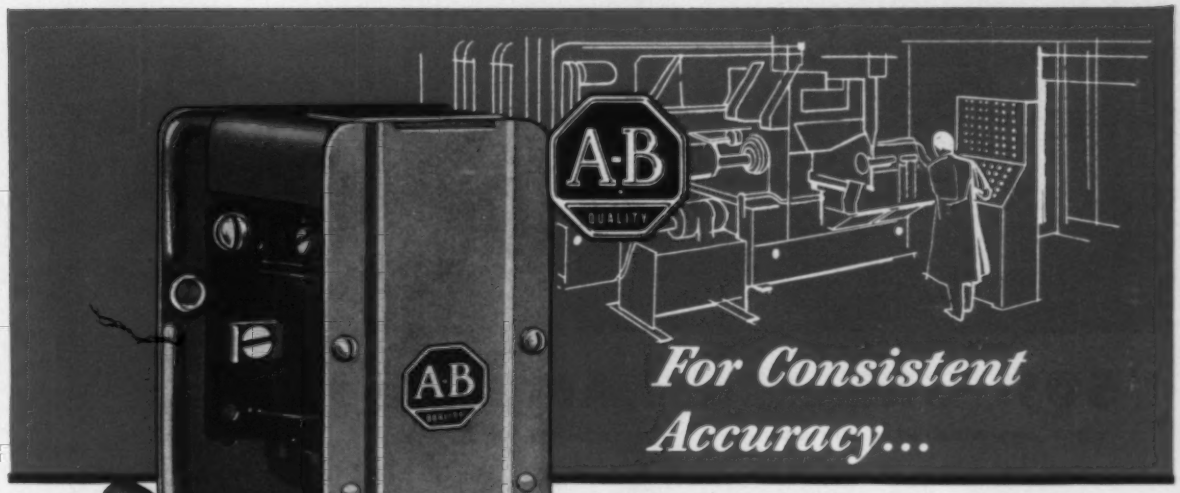
Electronic Timer

Type 940 electronic timer is a transistorized general purpose unit combining compactness, high load capacity, extended life, switching circuit versatility, and precision of control. Full-scale time ranges are 0.1, 1, 10, and 100 seconds. Three models are available for use as an interval timer, time delay relay, or cycling timer. Timer provides repeat accuracy of 1 per cent of full scale on all units. Control of the unit can be by sustained contact for all models, or momentary contact for the interval timer or the time delay relay. **Cramer Div., Giannini Controls Corp.**, Centerbrook, Conn.

Circle 457 on Page 119

Tapping Unit

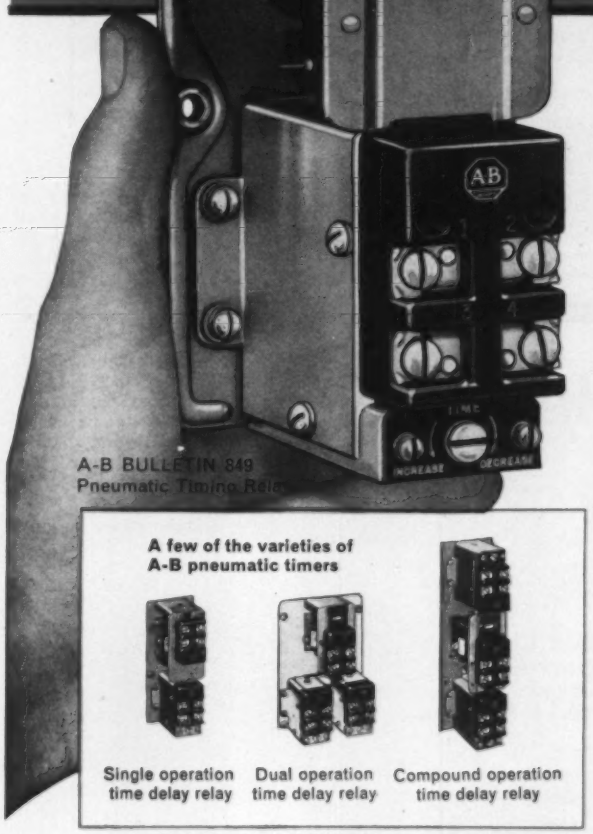
Automatic tapping unit uses an electric motor to drive the spindle and an air cylinder for the feed. A single direction motor is used with a reversing attachment to back out the tap. Unit will handle from #4-40 through #10 taps at speeds variable from 750 to 3000 rpm in seven steps. A pressure regulator is supplied



For Consistent Accuracy...

Specify

ALLEN-BRADLEY TIME DELAY RELAYS



A-B BULLETIN 849
Pneumatic Timing Relay

A few of the varieties of A-B pneumatic timers

Single operation time delay relay

Dual operation time delay relay

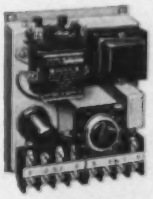
Compound operation time delay relay

For maximum production, high-speed automatic processes demand that the required operations "start" and "stop" at the correct instant, time after time—*without variation*. For consistent accuracy and trouble free operation, no timing relay on the market can equal the performance of A-B Bulletin 849 pneumatic timers. The delay period can be varied from 1/20 of a second to 3 minutes, and the setting will hold with an accuracy of ± 10%. Conversion from ON-DELAY to OFF-DELAY (or vice versa) is simple—no adjustment is necessary. Like *all* A-B control, these quality timers have maintenance free, double break, silver contacts. The two sets of contacts—one N.O. and one N.C.—are electrically independent, for greater control flexibility. Also, auxiliary contacts can be easily added.

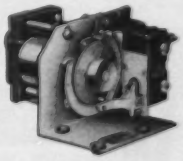
To make certain of a completely satisfactory electrical installation, specify Allen-Bradley "quality motor control"—in addition to the Bulletin 849 pneumatic timing relays. Write for details, today.

Allen-Bradley makes a broad line of timing relays to satisfy all automatic processes.

BULLETIN 848
Fluid Dashpot
Timing Relay



BULLETIN 852
Electronic
Timing Relay



BULLETIN 850
Motor Driven
Process Timer

ALLEN-BRADLEY *Quality Motor Control*

Member of NEMA

Allen-Bradley Co., 1339 S. First St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Circle 716 on Page 119

50% GREATER RANGE

when operated with any standard Electro sensing head

Actuated by non-magnetic and magnetic metals with Electro's exclusive "no-touch" circuit for detection or controlling electrical or mechanical devices in production or processing operations.

Up to 60′ of cable can be used with any standard Electro sensing head. Double voltage regulation insures proximity switch stability. The 4955D Control Amplifier is available with or without JIC enclosure.

Write for . . .
Bulletin 4955-361 and Detailed Catalog EDPS-80

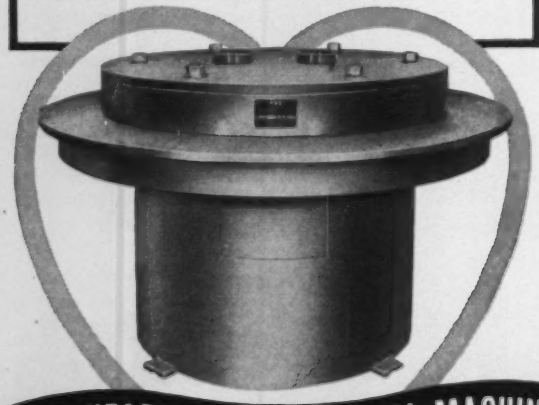
1936-1961 25th ANNIVERSARY

ELECTRO PRODUCTS LABORATORIES, 4501-A Ravenswood, Chicago 40
Canada: Atlas Instrument, Ltd., Toronto
Proximity Switches • Magnetic Pickups • Tachometers • DC Power Supplies
1240

Electro CHICAGO

Circle 717 on Page 119

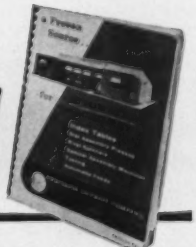
PDC
"AUTOMATIC"
CIRCULAR ASSEMBLY MACHINE



DIAMETERS
48″
60″
72″
84″
96″
Number of stations to suit your requirements.

YOUR CHOICE
- Electric Motor Drive
- Fluid Motor Drive
- Rotary Air Motor Drive

THE HEART OF YOUR SPECIAL MACHINE

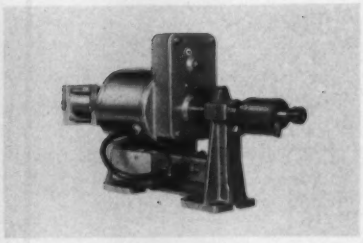


Can be used for assembly of pumps, motors, or any assembly requiring a combination of hand-loaded and hopper-fed parts for pressing, spinning, screwdriving, etc.

Write **TODAY** for new Catalog 60, for designers and engineers

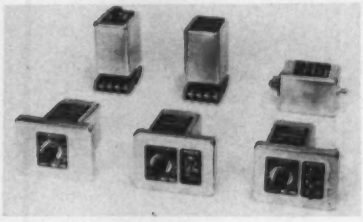
PRECISION DETROIT COMPANY
20100 SHERWOOD • DETROIT 34, MICHIGAN

Circle 718 on Page 119



with the unit to control the feed. **Electro-Mechano Co.**, 241 E. Erie St., Milwaukee 2, Wis.

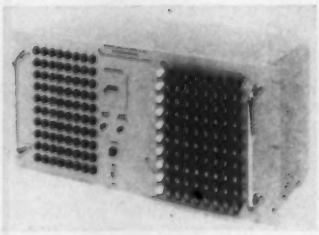
Circle 458 on Page 119



Time Relays

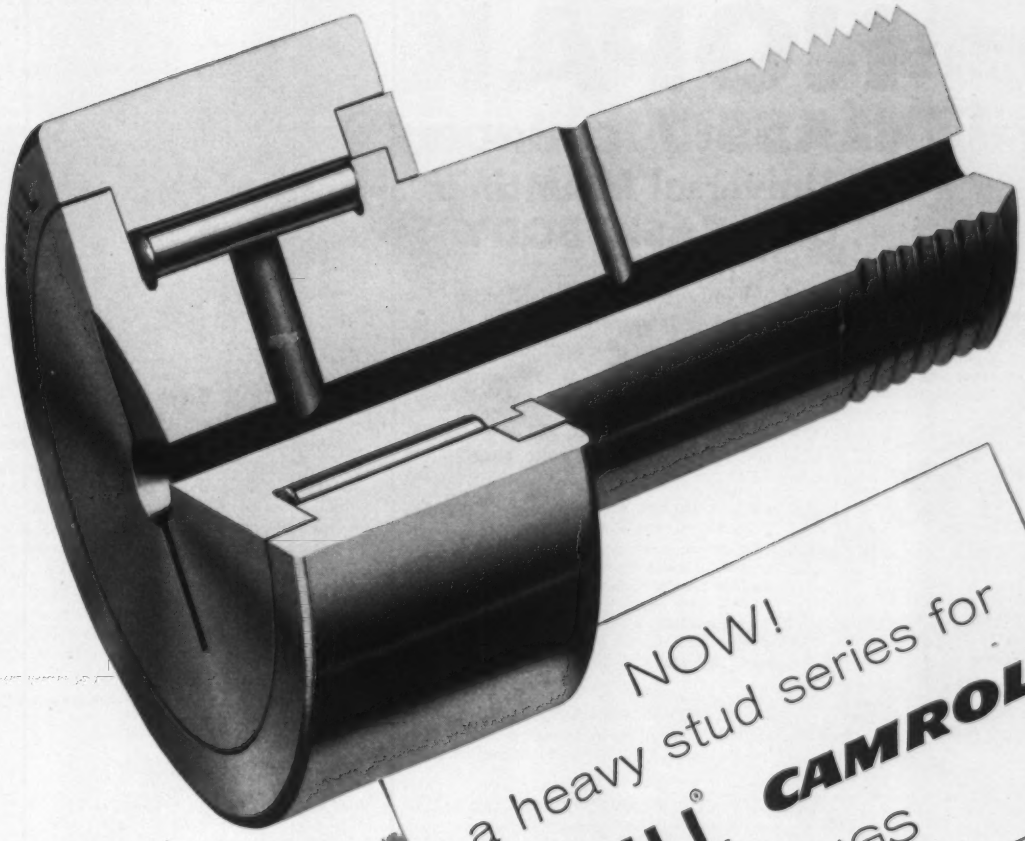
Reliable, transistorized, time relays are available in several styles of packaging. Different models function as on time delay, off time delay, or interval timer, with instantaneous reset action. They operate from ac or dc voltages and are voltage and pulse stabilized. Temperature ranges to 65C. Timing accuracy is ±5 per cent. Timing periods are available from seconds to over 1½ hours. A calibrated etched dial is available for adjustable units. The units can be surface mounted or flush panel mounted. Output may be either solid state or relay. **Clearview Electronics Corp. Inc.**, 140 E. Main St., P. O. Box 294, Elkton, Md.

Circle 459 on Page 119

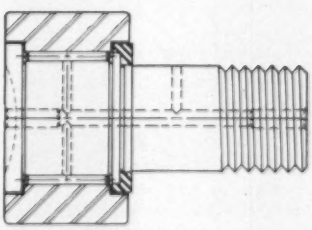


Program Simulator

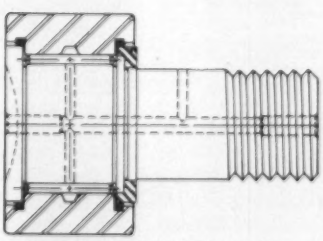
Device combines manual programming and automatic punch control for creation of program tapes in automation equipment. Transfer of the test configuration automatically from the simulator to the punched tape is accomplished without the preparation of a punching chart. The PS-425 may be substituted for a TP-400 Series tape reader to allow manual setup and cross check of a desired test configuration prior to punching of a tape. It will eliminate blind punching errors in complex programs. In this program simulator an 8-level, 10-row keyboard applies a 5, 6, 7, or 8-level code to the system for checkout purposes or punching of new



NOW!
a heavy stud series for
McGILL® CAMROL®
BEARINGS



CFH SERIES



SCFH SERIES WITH INTEGRAL SEALS

with integral seals in a wide range of sizes

These CFH and sealed SCFH series units provide a heavy stud for otherwise dimensionally standard CAMROL bearings. These new McGill cam followers offer increased diameter studs that provide greater shear strength to accommodate excessive stud deflection in critically loaded track, guide, support and cam follower applications.

SCFH series heavy stud CAMROL bearings with integral seals for lubricant retention and protection against contamination are dimensionally interchangeable with the unsealed CFH series.

Both series available from stock in roller diameters from ½" through 4"; larger sizes available on special order in production quantities.

For information and data on the complete line of McGill heavy duty needle roller bearings send for Catalog No. 62.

CONSULT McGILL EARLY
IN YOUR PRODUCT R and D
specialized engineering saves time, improves design

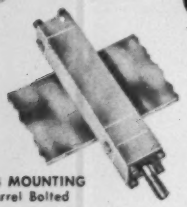
McGILL MANUFACTURING CO., INC.
Bearing Division
401 N. Lafayette St., Valparaiso, Ind.

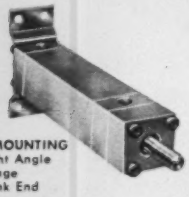
engineered electrical products
McGILL®
precision needle roller bearings

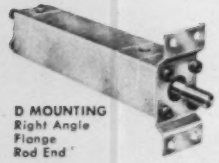
Circle 719 on Page 119

NOPAK®
CLASS 7 CYLINDERS
7 Universal Mountings
ONE BASIC BODY

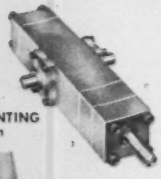
A MOUNTING
Parallel Base


BB MOUNTING
Barrel Bolted


C MOUNTING
Right Angle
Flange
Blank End


D MOUNTING
Right Angle
Flange
Rod End

E MOUNTING
Pivot Tongue


F MOUNTING
Trunnion

HB MOUNTING
Head Bolted

This is the only truly modular cylinder that is mass produced, yet gives you all the installation advantages of a custom-built unit. Any stroke length from 1″ to 20″ is immediately available in bores from ¾″ to 3.″ Pressure rated for 200 p.s.i., air; 1000 p.s.i., oil, in the most popular stroke lengths.

Roll 'em Over!

UNIQUE SQUARE BARREL†: Made of seamless extruded, aluminum alloy, drawn to a 16 micro inch finish, hard anodized to assure an extremely durable surface. Life tests reveal no wear in bore after millions of cycles. The four-square flush barrel provides unique and exclusive opportunity for direct bolt-in mounting into any of its sides or longitudinally from either end. (See Mounting HB & BB.)

Blitz Bolt 'em!

NO TIE RODS! NO LOCK RINGS! All components including Mounting Attachments neatly contained by only four (4) bolts at each end.

Shine 'em up!

STREAMLINED FLUSH FOUR SQUARE DESIGN — No tie rods; no humps; no bumps, no dirt catching, inaccessible, hard to clean contours.

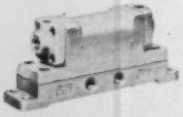
Hang one on!

MOUNTINGS UNLIMITED: — The 5 Universal Mounting Attachments are quickly bolted to the basic body. In addition, the four-square design allows rotating and inter-mixing these attachments. Now add to this the exclusive Direct Head Bolt and Barrel Bolt Mountings and NOPAK Class 7 becomes the most universal air and hydraulic cylinder ever developed. A natural for even the most difficult applications.

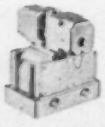
Spin 'em Around!

CYLINDER HEADS: — as well as head plate, are precision cast and machined aluminum alloy. The four-square heads can be readily rotated to position ports for most convenient piping. No matter how rotated, the heads align perfectly with the square barrel, resulting in clean, flush surfaces. Heads also provide opportunity for direct bolt-in mounting. (See Mounting HB.)

Other NOPAK "CVA*" Products



NOPAK "V" 4-Way, Pilot Operated Slide Valves Small, compact, 3- and 4-way valves for direct or remote control. Either single or double air pilot or solenoid actuated. Simple, proven design, durable construction insure trouble-free operation.



NOPAK - MATIC Poppet Type, Pilot Operated Valves Fast acting, high volume air valves from ¼″ to 1¼″ with master (air piloted) single or double solenoid. Side or bottom ported sub-plates or manifolds. Removing cover plates affords easy access to piston poppets housed within removable, interchangeable cartridges. 100% J.I.C.

†Patent Pending

*Cylinders, Valves, Accessories. NOPAK offers a complete line of matched Fluid Power components.

NOPAK
VALVES & CYLINDERS

NOPAK DIVISION
Galland-Henning Mfg. Co.
2734 S. 31st St., Milwaukee 46, Wis.

programs. Automation Div., Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif.

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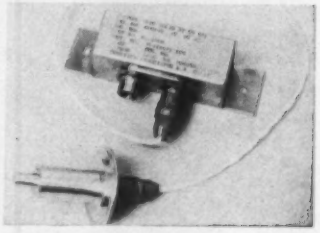
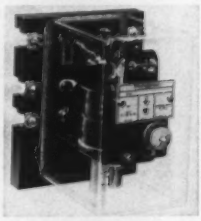


Solid State Switch

Ultrasonic liquid level control operates under extreme high shock and vibration environments. Welded into a stainless steel housing, the switch is universally suited to control engine cutoff and general propellant instrumentation applications ranging from cryogenics to corrosive storables. Specifications include: Input voltage +28 v dc; Output current less than 10 microamperes; response time from 2 to 20 milliseconds; resolution, 0.022 inch. **Acoustica Associates Inc.,** 10400 Aviation Blvd., Los Angeles 45, Calif.

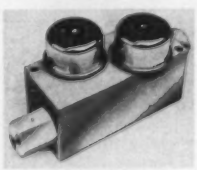
Circle 461 on Page 119



General Purpose Relays

Front connected relays (Types SC and SV) enclosed in a small glass case can be used as fault detectors to supervise main protective relays, or as protection of motors to prevent damage from high current or low voltage under abnormal conditions, where time-delay relays would not operate fast enough. These relays can be used on dc and 25 to 60-cycle ac without coil changeover. Relay contacts are reversible in the field so that two electrically independent contacts are available. **Westinghouse Electric Corp.,** P. O. Box 2099, Pittsburgh 30, Pa.

Circle 462 on Page 119



Flow Regulator

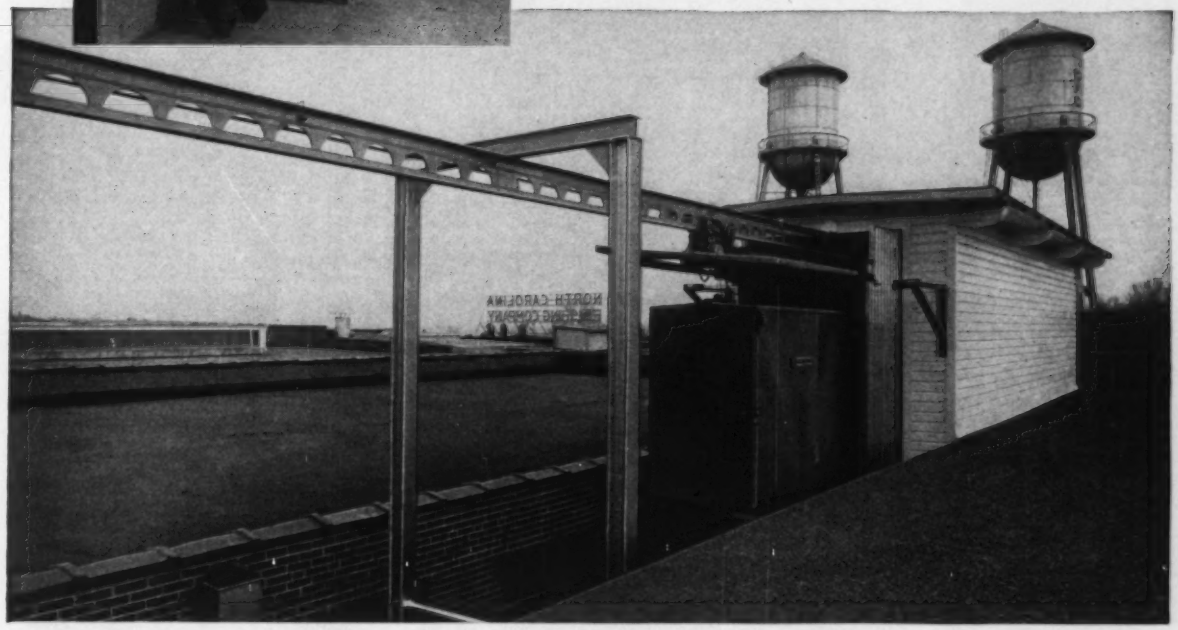
Double flow regulator can be installed in all types of fluid power systems, handling pressures of up to 3000 psi and re-

Uses Skyway For Handling Materials AUTOMATICALLY

Completely Pays for Itself Every Three Years

Loading a van on the second floor of a building. This same van also may be lowered to the floor below for loading. Although the building at this end of the system is quite old, the Cleveland Tramrail equipment was easily installed.

For years this vast roof area did nothing more than provide protection from the weather. Now it is being used profitably for materials handling. Illustrated is the van emerging from the penthouse.



BY erecting a Cleveland Tramrail materials handling system over the roofs of its buildings, a large plant is able to transport materials between departments located in widely separated buildings at very low cost.

Because the system operates automatically, the Tramrail carrier travels back and forth without any operator. The carrier van is loaded or unloaded at convenient areas inside the buildings. Pressing a button sends it on its way. It rises vertically to a penthouse on the roof. Then it makes its run over the track system to the penthouse at the other end. Here it lowers to the floor inside for loading or unloading.

The system eliminates considerable floor traffic and saves space required for wide aisleways. It operates at any time, day or night. Inclement weather does not hinder it. The system requires only a fraction of the maintenance necessary for floor handling equipment. It does not wear or damage floors. It is a big aid to safety. In addition to these important benefits, the Cleveland Tramrail system makes tremendous time savings — enough to completely pay for the entire installation every three years.

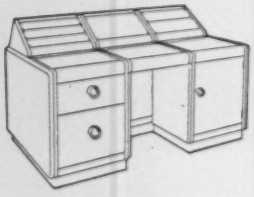
Cleveland Tramrail has had wide experience in automatic dispatch materials handling systems of many types. Our engineers will welcome an opportunity to work with you.

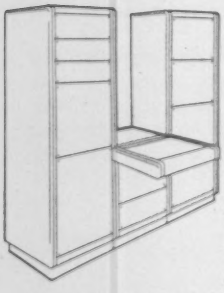
CLEVELAND TRAMRAIL
Overhead Materials Handling Equipment
TARCA TRACK assures more years of smooth service

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1319 E. 290 ST. • WICKLIFFE, OHIO

Circle 721 on Page 119

EMCOR® STANDARD CABINETS





- Cut enclosure design time. Select your packaging needs from a complete line of standard and heavy duty EMCOR Cabinets.
- EMCOR MODULAR ENCLOSURE SYSTEM Cabinetry provides for thousands of control center combinations.
- Choose from hundreds of EMCOR Cabinet widths, depths and heights offering an exclusive combination of engineered features.
- Engineered simplicity of basic frames and components affords quickest and easiest erection of control center assembly.
- EMCOR Cabinetry Engineers backed by the research and development "know-how" of the Roy C. Ingersoll Research Center set the pace for the packaging needs of electronics, instrumentation and electro-mechanical engineers from coast to coast.
- Rugged frame construction surpasses all standard requirements for increased load carrying capacities.
- Compatible cabinet design assures simplified and economical expansion at any time.
- EMCOR Cabinet manufacturing meets rigid quality-controlled craftsmanship standards.
- Nationwide organization of EMCOR Sales-Engineering Representatives assist in planning stages and assure customer satisfaction beyond the sale.

Condensed Version of Catalog 106 Available Upon Request.

Originators of the Modular Enclosure System

INGERSOLL PRODUCTS

Division of Borg-Warner Corporation

1000 W. 120th ST. • DEPT. 1231 • CHICAGO 43, ILLINOIS

QUALITY EMCOR PRODUCTS — INGERSOLL B-W PRODUCTS — BORG-WARNER

quiring manual adjustment of hydraulic fluid to two separate but associated functions. It features complete pressure compensation, 12 position detents, dustproof dial adjustments and bottom-located ports for simplified installation. The valve has four ports—an inlet, two 0 to 15 gpm regulated ports, and a bypass port. Inlet and bypass ports are ¾ inch pipe, and both regulated ports are ½ inch pipe. Single versions of this flow regulator valve are also available. **Fluid Controls Inc.**, P. O. Box 186, Mentor, Ohio.

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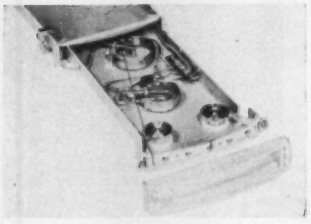


Pneumatic Receiver

Changing scales to suit changing process requirements is simplified in this Selectro-Scale pneumatic receiver. The receiver provides a multiple of scales in one receiver. Scales are printed on Mylar tape, stored on spools, ready for easy positioning on dial face when a change in process requires new scale values. Optional accessory is a high-low alarm switch. Specifications: Range, 3 to 15 psi (other ranges also available); scale length, 4.5 inches; tape capacity, 100 inches; accuracy ±1 per cent when adjusted for zero error at mid-scale. **United States Gauge Div., American Machine & Metals Inc.**, Sellersville, Pa.

Circle 464 on Page 119

Throw-Away Cylinder

Throw-away type cylinder has a ¾-inch bore, stainless steel body. It is a companion to a 1 1/16-inch bore cylinder and will find application where space is a factor. Cylinder is available in single or double acting models, with a choice of front nose, pivot, or double end mount. Precision built to last millions of cycles of operation, the cylinder can be used in all industry—food, plastics, textile, woodworking, metalworking, electronics, etc. **Bimba Mfg. Co.**, 101 Main St., Monee, Ill.

Circle 465 on Page 119

Latching Relay

Mechanical latching relay with manual reset is applicable as a guard relay in any system where, once operated, it should not restore until fault is found

Circle 722 on Page 119

New Westinghouse digital draw-speed indicator instantly reports precise strip process speeds and speed differentials

Immediate knowledge of speed differentials, surface speeds, section speeds, speed ratios, improper slack, and drift is vital to improved product quality, uniformity, and output in the strip process industries.

The new Westinghouse digital draw-speed indicator has been designed to meet your accurate process speed requirements. This digital instrument measures surface speeds, speed difference between sections, and speed ratios between sections with accuracies of .1 foot per minute or 1 foot per minute. The completely transistorized digital indicator is entirely free from drift and retains its initial accuracy indefinitely.

This versatile product continually monitors speeds and draws, allowing fast location and trouble shooting of the causes of machine variations. In addition, it isolates the source of trouble to either regulator or mechanical problems.

It provides information that eliminates trial-and-error machine set-up. It permits the operator to accurately set up the ideal speed or draw on any given machine section, based on recorded data from previous runs.

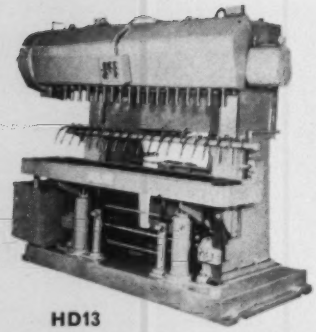
Already proven in the paper and plastics industries, this new development is well suited to other strip process industries such as aluminum, steel, textile and rubber.

For more information, contact your Westinghouse representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-40540

Westinghouse

Circle 723 on Page 119

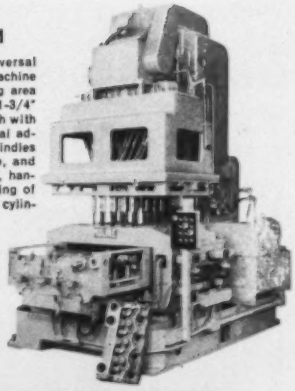


HD13

straight line drilling machine with hydraulic table feed and 18 spindles each having 11/16" diameter drill capacity in mild steel. Spindle center distances are adjustable along the 6-foot machine rail.

MODEL HU111

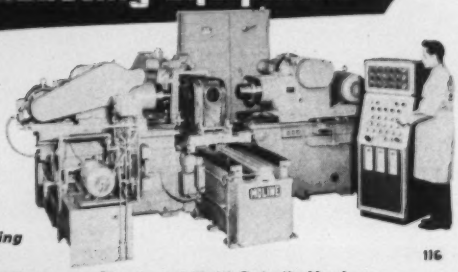
Hydraulic Feed, Universal Joint-Type Drilling Machine with 24" x 50" drilling area and with forty-two 1-3/4" spindle drivers, each with two-speed and neutral adjustment. Thirty-six spindles in slip spindle plate, and power shifting fixture, handle drilling and reaming of three different engine cylinder heads.



MOLINE Cost Reducing Equipment

MODEL MR148

Three-way, three-spindle, horizontal boring machine with selective automatic feed cycle. Handles boring of cylinder and crank bore for 3 sizes of 1-cylinder blocks. Also bores for wet sleeves in 2- and 3-cylinder blocks.



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REPRESENTATIVES IN PRINCIPAL CITIES

Circle 724 on Page 119

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helps maintain production line efficiency

Randolph Mills uses Tachographs to measure production efficiency and time. When one shift in finishing fell far behind production, a Tachograph showed that the wash range machine wasn't draining water fast enough . . . pinpointed the situation that needed correction.

Tachographs are precision recording devices that can be used anywhere the control of speed, time and measurement is essential to the quality of your products. They can help you determine production peaks and valleys, and non-productive time. Chances are, they can help increase your plant's efficiency. Mail coupon below for full information.

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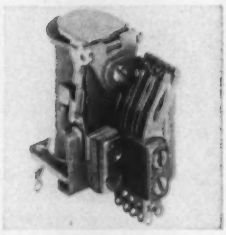
Company_____
Address_____
City & State_____
Proposed Application_____

W161-3

Circle 725 on Page 119



and corrected. Such applications include alarm circuits of many kinds and vending machines where a circuit fault might permit items to be dispensed free. The Series EML relay in such a circuit would be actuated by the fault and would remain operated until a serviceman corrected the trouble and reset the relay manually. This relay is available with ac or dc coils, up to 220 volts, and has a life expectancy of 100 to 200 million operations. It has a contact capacity of 13 springs on one pileup, and 12 on the other. Automatic Electric Sales Corp., Northlake, Ill.

Circle 466 on Page 119

Pneumatic Pumps

Four-vane air pump Models 30-3 and 30-6 can be used in vacuum, pressure, or gas boosting operations. Units can provide vacuum to 26 inches Hg, pressure to 13 psig and volumes from 12 to 54 cfm. Pumps have cast iron housings and rotors, with four sliding vanes which maintain contact with housing by centrifugal force. These pumps are equipped with antifriction bearings, rotary mechanical shaft seals, inlet filter and automatic oilers. Leiman Bros. Inc., 102 Christie St., Newark 5, N. J.

Circle 467 on Page 119

Electronic Controller

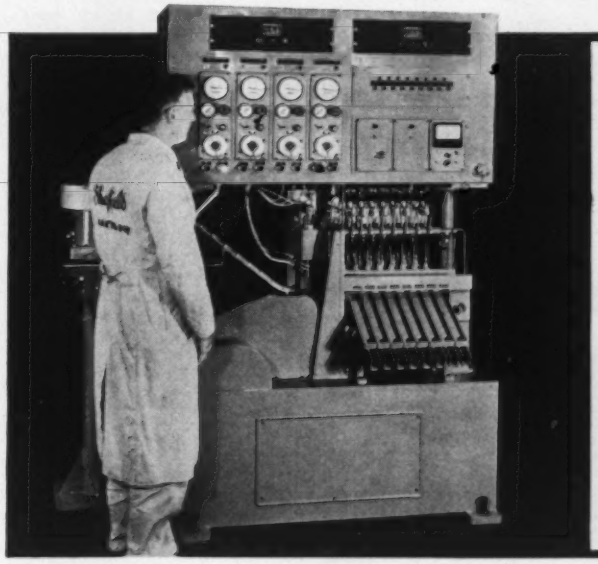
Automatic operation and timing of up to a dozen valves in sequence is made possible by this miniaturized electronic controller. Especially suitable for controlling water flow in industrial processes, the unit is used in conjunction with No. 1825 electric remote control valves. It is

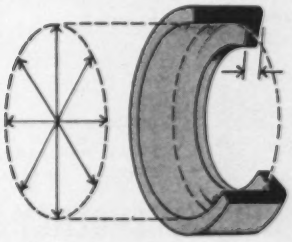
A **Sheffield sorter*** sorts 2000 rings an hour

2000 rings an hour a **Sheffield sorter*** sorts.

If a **Sheffield sorter*** sorts 2000 rings an hour

Where are the 2000 rings the **Sheffield sorter*** sorts?





*This Sheffield automatic gaging, classifying and segregating machine inspects up to 2,000 rings an hour for the Western Electric Company. It simultaneously measures inside diameter and flange thickness, classifies rings into 15 sizes plus out of tolerance, and rejects each size in its chute. Its speed and accuracy have resulted in appreciable manufacturing savings.

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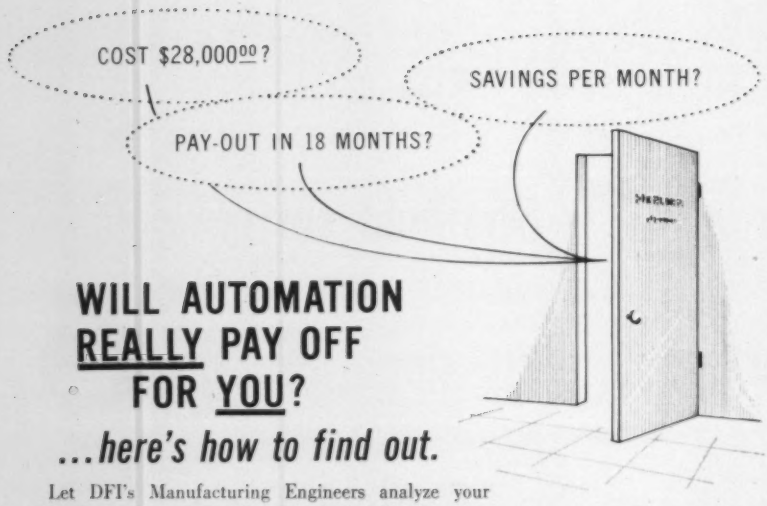
Gages, Measuring Instruments, Automatic Gaging & Assembly Systems • Machine Tools • Contract Mfg.

Circle 726 on Page 119



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- building equipment costs
- installation
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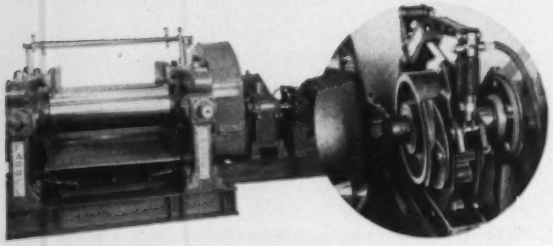
Circle 727 on Page 119

WAGNER® EMERGENCY BRAKE SYSTEM



Stops "Inrunning rolls" within safety limit

A Wagner® A/H Emergency Brake System protects the operator of this Farrel-Birmingham rubber mill against the hazards involved in operating machinery with inrunning rolls. An industrial-type brake is applied by an air-operated hydraulic power cluster to smoothly stop rolls well within the limit set by safety codes. The Wagner system minimizes strain on the machine drive, and incorporates safety devices that provide protection in the event of power failure or loss of air pressure.

Wagner brake systems are easy to install . . . don't need special motor starters or controls, or direct current. Need little care, too . . . there is practically no lining wear; no heavy solenoid coils to burn out.

Apply these systems to your rubber or plastic mills, refiners, washers, crackers. Available with 6, 8, 10, 14, or 18 inch diameter brakes. Get full details from your Wagner Sales Engineer.

Wagner Electric Corporation

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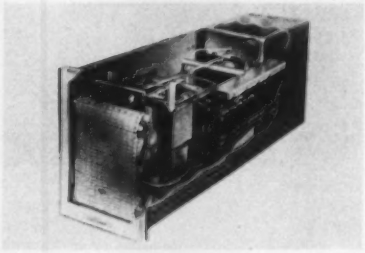
Circle 728 on Page 119

made in two sizes, Model C-6 for operating up to 6 valves, and Model C-12 for up to 12. Both are available with an auxiliary circuit that will operate a booster pump whenever a valve is opened. **Febco Inc.**, 1993 Blake Ave., Los Angeles 39, Calif.

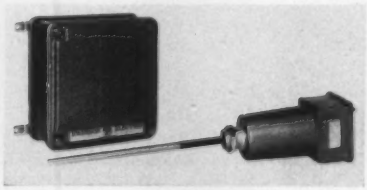
Circle 468 on Page 119



Solid State Recorder

Miniaturized solid state recorder features encapsulated circuits. The use of transistors eliminates warmup, reduces power consumption, and permits battery operation during emergencies. One, two, or three pens travel the full width of a four-inch chart. Six inches of chart are visible. Input span of the potentiometer is continuously adjustable from 0-5 mv to 0-50 mv. As receiver-recorder (without internal preamplifier) input system spans start from 0-1 v or 0-100 microampere. Unit is especially suited for use with strain gage transducers, thermocouples, and resistance bulb elements. Dc input isolation provides high common mode noise rejection and permits low noise dc output for use by data loggers and computers. **De Var Systems Inc.**, Glenbrook, Conn.

Circle 469 on Page 119

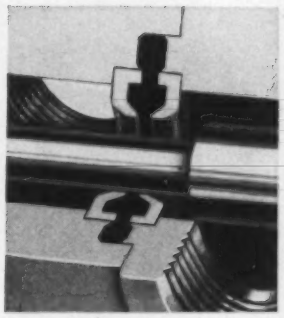


Level Control System

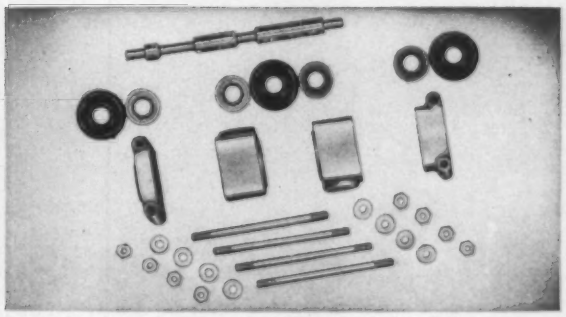
Materials such as flour, sand, coal, cement, brine, plastic granulars, and fruit juices can be controlled by this transistorized level control system. Featured is an electronic medium frequency control module and a static transistorized circuit mounted on an industrial type printed circuit board. The Transi-Level control system can be equipped with a wide variety of probe heads such as ceramic angle probes for use with powdered materials, heavy-duty probes for use with materials such as coal or gravel, flush probes for use in rotating stirrers, extension type probes for use in detecting the level of power plant fly ash buildup or the level of cement or sand in large bins. **Industrial Electronics Div., Emerson Electric Mfg. Co.**, 8100 Florissant Ave., St. Louis 36, Mo.

Circle 470 on Page 119

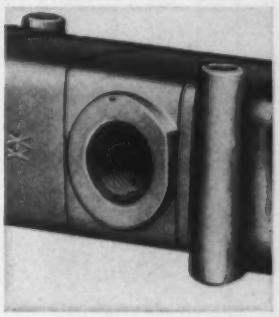
Do the air valves you buy include these quality features?



SEAL—Exclusive, triple-supported seals permit interference fit of spool for extra-tight closure with minimum wear. Usual damage to conventional "O" rings by moving spool is eliminated.

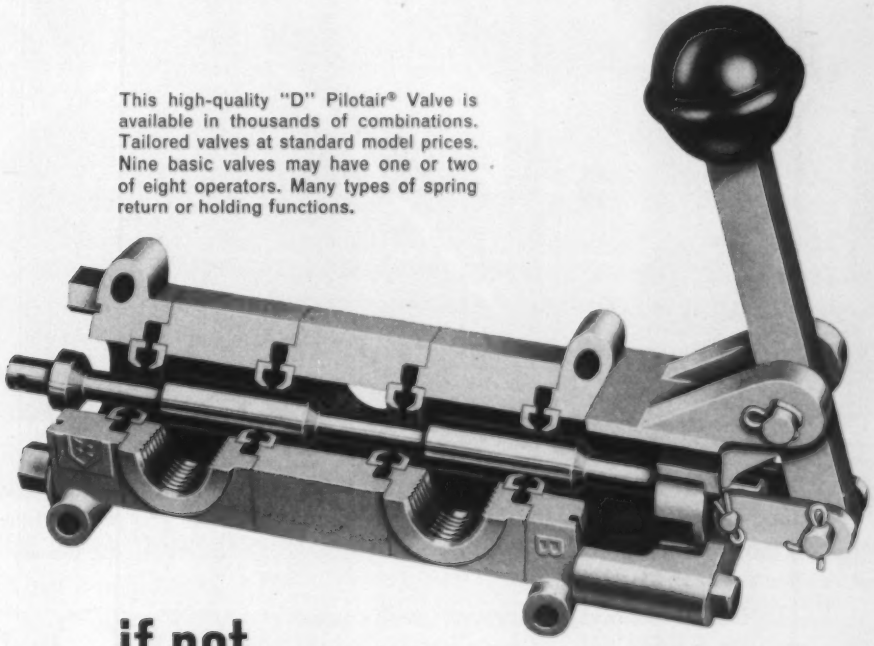


SIMPLICITY—Uncomplicated parts mean long life and easy servicing. Common parts are used extensively to simplify stocking or repair.



FLEXIBILITY—Modular Construction. Operators, mounting holes and ports may be independently rotated in 90° steps. Operator may be on either or both ends.

This high-quality "D" Pilotair® Valve is available in thousands of combinations. Tailored valves at standard model prices. Nine basic valves may have one or two of eight operators. Many types of spring return or holding functions.



if not, the chances are your maintenance costs are higher than necessary. For more information about quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A4-75.01.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

The cylinder simplifies your design work substantially, because it produces virtually any kind of motion—and does so *without the use of complex mechanical contrivances!*

It provides constant, even pressure at all times, and this pressure can be varied with a simple adjustment. Its compact size, along with the use of a flexible line, makes it easily adaptable to special machine design.

If you would like more information about cylinders, or the many other Logan products, just fill in and mail the coupon below.

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Circle 730 on Page 119

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 119.

Dry Materials Feeder

Vibra Screw Feeders Inc., 156 Huron Ave., Clifton, N. J.—4 page pamphlet—Development, construction details, and features of this Live Bin Feeder for metering dry materials are described in bulletin. A partial list of more than 250 solid materials that have been metered by the feeder indicates its wide use in such industries as ceramics, building materials, chemical, petroleum, plastics, rubber, wood, paper, and pulp. Metering rates for solids in various screw sizes of the feeder range from 0.12 to 8400 lb per hour.

Circle 471 on Page 119

Variable-Speed Sheaves

T. B. Wood's Sons Co., Chambersburg, Pa.—16 page booklet—Data are contained in Bulletin 25103 on two types of variable-speed sheaves. The MS and MCS sheaves embody a design concept that eliminates freezing and sticking from fretting corrosion, allows them to run indefinitely at one speed, and affords easy speed adjustment. MS sheaves are rated at from 2 to 15 hp, and MCS sheaves are rated at from 7.5 to 20 hp.

Circle 472 on Page 119

Temperature Transmitter

Foxboro Co., Foxboro, Mass.—12 page booklet—Bulletin 13-17C contains data on a Type 12A pneumatic temperature transmitter. It illustrates how the device can be installed and adjusted to suit a wide range of application requirements. Accuracy of this transmitter is ±0.5 per cent; repeatability ±0.2 per cent of span. Sensitivity is less than 0.04 per cent of span, and response is less than 2 seconds to reach 63 per cent of a step change in temperature. Bulletin provides a table of temperature ranges and data on accessories.

Circle 473 on Page 119

General Purpose Computer

Computer Div., Bendix Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.—4 page pamphlet—Application Report 17 details how a G-15 computer enables a company to conduct a complete order control and billing operation, while also providing an invaluable tool to its research department. The system processes daily sales information and aids in invoice preparation. Customer invoicing is accomplished within 24 hours after shipment. Sales reports may be produced in any conceivable fashion, with the use of magnetic tape eliminating the need for mass card handling.

Circle 474 on Page 119

Solenoid Operated Valves

Oilgear Co., 1571-A W. Pierce St., Milwaukee 4, Wis.—4 page pamphlet—Bulletin 80125 covers a line of solenoid operated fluid power pilot (directional) valves for pressures up to 3000 psi. Information included covers: Construction features; dimension data; specification data; photographs, flow diagrams; ASA symbols; and type designation for all sizes and types of these valves.

Circle 475 on Page 119

Infrared Processing Equipment

Fostoria Corp., Fostoria, Ohio—4 page pamphlet—Bulletin 61-124 contains data regarding a line of high intensity electrical radiant energy equipment that utilizes fluid cooling to obtain maximum capabilities of quartz lamp sources. This equipment can produce temperatures of up to 3000 degrees in continuous operation. It can be built in either horizontal or vertical banks, in cylindrical ovens, or can be engineered for totally enclosed batch furnaces of spherical or other shapes.

Circle 476 on Page 119

Pressure-Sensitive Adhesives

Topflight Corp., 160 E. 9th St., York, Pa.—12 page booklet—Applications for pressure-sensitive tapes and labels in manufacturing, shipping, warehousing, and selling are covered in Bulletin TB-61-15M. Adhesives, backing stock, and laminations may be found to meet practically any desired condition of adhesion and/or resistance to weathering, moisture, heat, cold, electricity, and abrasion. A pressure-sensitive planning guide lists 14 frequently used liner-backed labeling materials and 21 tapes, giving physical characteristics and suggested uses.

Circle 477 on Page 119

Spectrochemical Instruments

Baird-Atomic Inc., 33 University Rd., Cambridge 38, Mass.—6 page pamphlet—Data are contained in Bulletin SC-1 on a line of emission spectrochemical instruments. Covered are the following: A 3-meter spectrographic laboratory for a variety of quality control problems and for research; direct reading spectrometers for melting control or large volumes of repetitive analysis; and a research type direct reading spectrograph. Basic principles of operation are explained.

Circle 478 on Page 119

Case and Bag Checkweigher

Exact Weight Scale Co., 541 E. Town St., Columbus 15, Ohio—2 page pamphlet—Data are contained in Bulletin 3376 on a Model 1250 Selectrol checkweigher designed for installation on new or existing production lines. This machine performs automatic checkweighing, classifying, and recording of filled cases and bags in any weight from 25 to 150 lb. Depending on size and weight, open or sealed cases can be weighed at speeds up to 40 units per minute. Bags can be weighed at rates up to 25 per minute.

Circle 479 on Page 119

Belt Sander

Yates-American, Beloit, Wis.—4 page pamphlet—Model S-25 belt sander is subject of this brochure. It is a high production machine that combines fast stock removal with fine finishes. Features of the machine include: Automatic belt tracking mechanism, infinitely variable feed adjustment from 20 to 60 fpm, and precision screw-operated depth of cut adjustment.

Circle 480 on Page 119

Hydraulic Power Units

Oil-Dyne Inc., 2115-E W. Marquette Rd., Chicago 36, Ill.—76 page catalog—Catalog 21 covers a line of hydraulic power units including pumps, cylinders, valves, pressure switches, and accessories. Ninety-six basic models of a miniaturized hydraulic pump are described and illustrated. Cylinders described have bore sizes from ½ inch to 4 inches.

Circle 481 on Page 119

Anodes and Plating Chemicals

Hanson-Van Winkle-Munning Co., Church St., Matawan, N. J.—8 page bulletin—Bulletin AC-113 illustrates and describes a line of anode accessories and chemicals for electroplating and metal-finishing. Nickel, cadmium, brass and bronze, copper, lead, and zinc anodes are

HANNIFIN
has a faster, more rugged
AIR MOTOR

Truly a convenience package, the Hannifin Air Motor combines a rugged, low-friction, double-acting air cylinder with a solenoid valve. Ample air passages permit rapid cycling. Built-in speed controls make it possible to slow either or both strokes. Mounting dimensions interchange with most existing applications. "Off shelf" delivery in "standard" strokes. Bulletin 215—free on request—describes this new product.

9155-P1Ha

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SCHIPHOL • THE NETHERLANDS

Circle 731 on Page 119

described. Various types of nickel anodes are listed along with recommended applications and pH ranges. Drawings give instructions on how to order hooks for round, flat, and shaped lead anodes. Descriptions and recommended applications are given for several styles of anode bags. Details are also provided on titanium anode baskets that provide for complete use of nickel scrap metal or electrolytic nickel squares.

Circle 482 on Page 119

Rubber Deflashing Process

Wheelabrator Corp., 1109 S. Byrkit St., Mishawaka, Ind.—12 page booklet—Bulletin 178-D discusses a mechanical rubber deflashing process. The deflasher eliminates the hand labor from deflashing and mechanically removes the flash from large quantities of molded rubber parts in minutes. A major portion of the bulletin is devoted to a pictorial description of the various types of moldings for which mechanical deflashing provides the greater cost savings.

Circle 483 on Page 119

Magnetic Drives

Louis Allis Co., Dept. P, 427 E. Stewart, Milwaukee, Wis.—6 page pamphlet—Data are given in Bulletin 3650 on a line of magnetic adjustable speed drives, available in ratings from 50 through 2500 hp. The drives can be applied in many varied applications including draw benches, extruders, wire drawing machinery, calenders, pumps, and rolling mills. Features of the units include stationary field coil construction, liquid or air cooled clutch systems, and ac tachometer generators.

Circle 484 on Page 119

Assembly with Eyelets

Fastener Div., United Shoe Machinery Corp., Shelton, Conn.—4 page pamphlet—Bulletin E104 discusses the advantages of using this particular line of eyelets for cutting the installed costs of assembly. A section of the bulletin explains that a system of 65 standardized eyelet sizes requires only seven sets of tools. Co-ordinated lines of eyeleting machines, tools, and eyelets are available.

Circle 485 on Page 119

Unit Mechanization

Jetted Equipment Co., 1300 S. Coolidge Rd., Birmingham, Mich.—12 page booklet—An approach to automation based upon unit mechanization of specific or related work functions, is described and illustrated in this brochure. Included are typical examples of special automated machines which have been designed and built to perform various manufacturing, inspection, assembly, and testing operations on parts and components in the automotive, aircraft, appliance, electrical, and hardware industries.

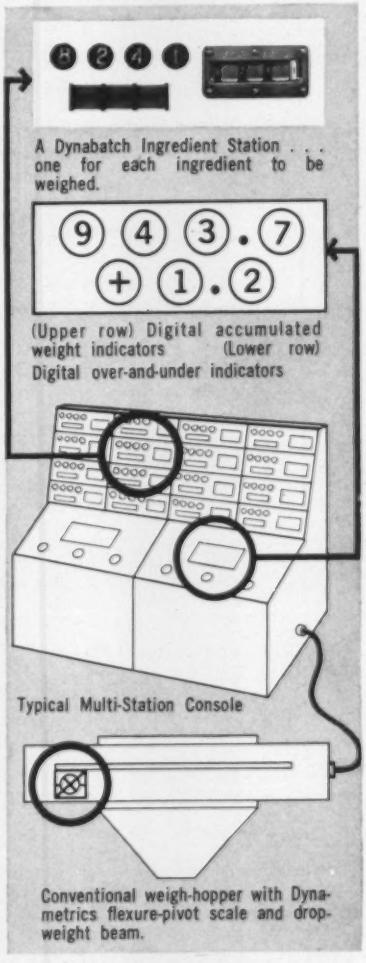
Circle 486 on Page 119

Forming Machine

A. H. Nilson Machine Co., 600 Bridgeport Ave., Shelton, Conn.—32 page handbook—Design and tooling handbook has been developed to increase the understanding of the fourslide process of forming wire and ribbon metal. Included in the

THIS IS DYNABATCH

an Automatic Weighing System with Direct Digital Setting and True-weight Indication


A Dynabatch Ingredient Station . . . one for each ingredient to be weighed.
9 4 3 . 7
+ 1 . 2
(Upper row) Digital accumulated weight indicators (Lower row) Digital over-and-under indicators
Typical Multi-Station Console
Conventional weigh-hopper with Dynametrics flexure-pivot scale and drop-weight beam.

- Direct digital setting and true-weight indications
- Accepts digital inputs from card-readers without analog conversion
- Completely self-checking
- Modulated feeder controls
- Exclusive Dynametrics flexure scales throughout
- All major components plug in

Dynametrics manufactures a complete line of automatic weighing equipment. Write for Catalog 200, an illustrated 20-page handbook on automatic weighing.

DYNAMETRICS CORPORATION

Northwest Industrial Park,
Burlington, Massachusetts • BRowning 2-1600

Circle 732 on Page 119

booklet are actual examples of fourslide jobs as well as illustrations of various parts produced. Secondary operations such as welding, assembling, winding, and chamfering, which can be incorporated into a machine of this type are discussed. Schematic diagrams illustrate operations performed by various tools of the machines in producing several different parts.

Circle 487 on Page 119

Heating Furnace Controls

GPE Controls Inc., 240 E. Ontario St., Chicago 11, Ill.—24 page handbook—Data are contained in Folio 122 on automatic controls for open hearth furnaces, glass tanks, reheating and annealing furnaces, and soaking pits. Both hydraulic and electrohydraulic types of systems are covered, with diagrams illustrating the best types of applications for each control method. Subsystems covered in detail are furnace pressure controls; heat input controls; fuel-air ratio controls; automatic reversal of regenerative furnaces; summarization and control of two or more fuels; and temperature controls.

Circle 488 on Page 119

Thermocouple Materials

Temptron Inc., 7030 Darby Ave., Reseda, Calif.—12 page booklet—Catalog 2550 describes the process used to produce Tempak thermocouple materials and gives specifications and descriptive data on the metal-sheathed, ceramic-insulated wire. Booklet also describes this company's facilities and its comprehensive in-process quality control system.

Circle 489 on Page 119

Airless Spray Equipment

DeVilbiss Co., Toledo 1, Ohio—4 page pamphlet—Form 1-3505 covers a line of airless spray equipment. It lists specifications and information on a medium production pump for single gun operation, including available accessories; a heavy duty pump for multiple gun operation, including portable and tank mounted models; spray guns, including pole and automatic guns; a range of spray caps; and various types of hose and connections.

Circle 490 on Page 119

Display Screens

Micro Switch, Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.—2 page pamphlet—Data Sheet 193 covers four display screen types available for use with lighted display and pushbutton switch devices. Described are truncated pyramid screens, colored rim cap screens, colored base screens with clear transparent caps, and screens for a balanced brightness effect. These screens serve as both an operating button and a lighted display in Series 2 operator-indicator modules, and as a lighted display only in indicator modules.

Circle 491 on Page 119

Drives and Couplings

Dodge Mfg. Corp., Mishawaka, Ind.—20 page booklet—A simplified method for selecting Flexidyne dry fluid drives and couplings for most industrial applications is featured in Bulletin 70. Eight stock drives and 11 stock couplings are listed for fractional to 1000 hp requirements, together with actual installation photographs, product pictures, and engineering drawings. Bulletin also has tables of weights, dimensions, and prices; details on two types of cutouts to shut off motors in case of prolonged slippage due to unattended overload; and tables of recommended V-belt drives for use with various sizes of the drives and couplings.

Circle 492 on Page 119

General Purpose Relays

Elgin Advance Relays, Electronics Div., Elgin National Watch Co., 2435 N. Naomi St., Burbank, Calif.—8 page bulletin—Data are provided in this booklet on a GH Series general purpose relay line. Included are specifications, typical applications, and dimensional drawings as well as a contact arrangements chart illustrating contact symbols and designations for all basic contact arrangements listed by the National Association of Relay Manufacturers.

Circle 493 on Page 119

Linear Programming System

Computer Div., Philco Corp., Marketing Dept., Willow Grove, Pa.—4 page pamphlet—Details are provided in this bulletin regarding a Model LP-2000 linear programming system used in conjunction with a Philco 2000 computer. Advantages of the system are explained, and various applications indicated. This system can rapidly solve problems involving as many as 3000 equations.

Circle 494 on Page 119

Hinged Steel Belting

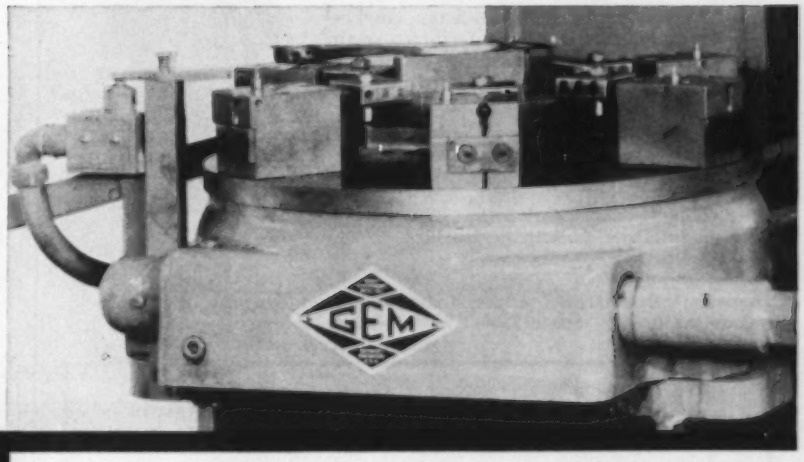
May-Fran Mfg. Co., 1710 Clarkstone Rd., Cleveland 12, Ohio—6 page pamphlet—Bulletin MF-600-A contains details

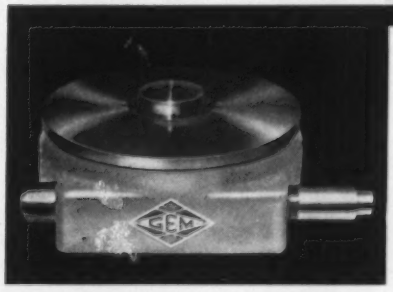
precision indexing to ±0.001"

. . . WITH GEM-17 DIAL INDEX TABLE!

FAST	Geneva motion smoothly positions in speeds up to ½ sec.
RUGGED	1000 lb. work load with solid anvil capacity of 30 tons.
POSITIVE LOCK	Bolt in Geneva slot cammed both in and out given positive locking.
POWER	Comes complete with rotary air motor, solenoid valve with limit switch (fluid or electric motors available).
NUMBER OF STATIONS	6, 8 or 12 standard, 3 and 4 skip.
SIZE AND WEIGHT	200 lbs. complete with 17" dia. table (plates up to 36" available).

GEM-17 mounted on GEM ATP-6, 6 ton toggle press with standard GEM base.





Geneva Motion GEM-17 Indexing Table standardizes automation on your assembly and machining operation . . . drilling, tapping, riveting, spinning, staking, knurling, chamfering, welding, screwdriving, stud driving and gaging to the speed and accuracy required. Gray's complete engineering staff can adapt the table to your work problem.

Send for Bulletin DI-17 and complete information.

gem

GRAY equipment company

13600 Ford Road • Dearborn, Mich. • Telephone: Tiffany 6-7373

Circle 733 on Page 119

regarding hinged steel belting that is constructed of heavy gage steel and capable of withstanding extreme wear caused by sharp or rough materials. This belting can be assembled in virtually any required width or length from stock, interchangeable component parts.

Circle 495 on Page 119

Manometers

Dynametrics Corp., Northwest Industrial Park, Burlington, Mass. — 8 *page bulletin*—Manometers, theory and applications, are described in detail in this illustrated brochure. Covered are well-types, U-types, movable well-types, slant-tube types, etc.

Circle 496 on Page 119

Compression Tube Fittings

Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio—20 *page booklet*—Catalog 4323 furnishes details regarding 25 items of a Ridg-lok tube fitting line. The fittings feature reversible ferrule; both ends are identical so there is no danger of putting it in backwards. They are made in type 316 stainless steel. Sizes range from 1 through 16 for tubing of 1/16 through 1 inch outside diameters.

Circle 497 on Page 119

Air-Actuated Clutches

Fawick Airflex Div., Fawick Corp., 9919 Clinton Rd., Cleveland 11, Ohio—4 *page pamphlet*—Bulletin ML-199 entitled "Design or Modernize Heavy-Duty Grinding Mills" pinpoints cost-saving potentials of air-actuated clutches used in heavy-duty grinding mill drives. It describes the advantages of air clutches in the drive systems for ball mills, tube mills, pebble mills, and rod mills. Details on a typical ball mill application are provided.

Circle 498 on Page 119

Test Instruments

Minneapolis-Honeywell Regulator Co., Station M389, Wayne & Windrim Ave., Philadelphia 44, Pa.—48 *page catalog*—Data are provided in Catalog G-10b on a line of instruments and systems widely used for measurement, recording, and testing. Covered are amplifiers, components, data handling systems, laboratory and calibration instruments, magnetic tape instrumentation, nuclear instrumentation, oscillographs, electronic medical systems, recorders and indicators, relay racks, temperature controllers, temperature sensing elements, and process transmitters. All items are illustrated.

Circle 499 on Page 119

Horizontal Mixers

Robinson Div., Young Machinery Co. Inc., Muncy, Pa.—12 *page booklet*—Bulletin M/1058A covers a line of horizontal mixers for free flowing, granular materials. Design, technical, and dimensional data are included for mixers ranging in capacity from ½ to 500 cu ft. The catalog covers standard, trowel type, and special units with adaptations for heating, cooling, drying, or liquid additions. Low pressure and high pressure steam or baffled water jackets are available.

Circle 500 on Page 119

Terminal Panel Wiring Block

AMP Inc., Eisenhower Blvd., Harrisburg, Pa.—1 *page pamphlet*—Folder details specifications on a modular terminal panel wiring block designated Termi-Blok. This unit is designed to replace barrier boards and terminal boards presently in use in switchboards, control panels, industrial instrumentation, and other applications where maximum versatility of control and power circuit distribution are essential. Advantages include high density per lineal inch of track and terminal insertion without tools.

Circle 501 on Page 119

Viscosity Control Systems

Norcross Corp., 247 Newtonville Ave., Newton 58, Mass.—2 *page pamphlet*—Line of automatic viscosity control systems is described in Bulletin V-1225. These systems are ideal for flexographic and rotogravure printing. Basic system diagramed in bulletin is widely used for all types of finishing applications. Features of the systems are explained, as well as principles of operation.

Circle 502 on Page 119

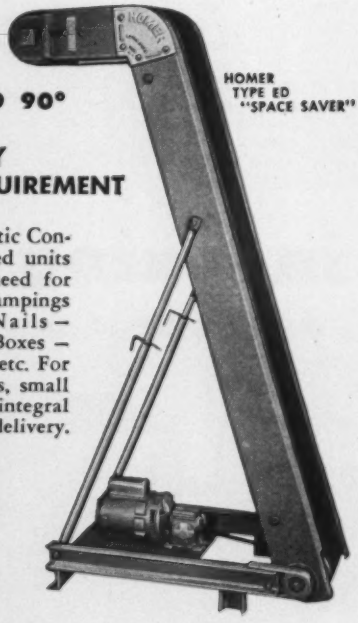
Time and Torque Controls

Haydon, Div., General Time Corp., Torrington, Conn.—3 *pamphlets*—Form G-1681 describes a reset Acrotimer that provides delay or interval timing to open or close one or more switches after an adjustable period of time. Form G-1784 covers a line of elapsed time indicators

HOMER

"SPACE SAVER" MAGNETIC CONVEYORS

- **SPEED UP PRODUCTION**
- **SAVE FLOOR SPACE**
- **CUT LABOR COSTS**
- **CONVEY AT ANGLES TO 90°**



HOMER TYPE ED "SPACE SAVER"

A TYPE AND SIZE FOR EVERY MAGNETIC CONVEYING REQUIREMENT

There are Homer "Space Saver" Magnetic Conveyors in standard and custom-designed units to meet practically every conveying need for ferrous metal parts such as Blanks – Stampings – Nuts – Bolts – Rods – Gears – Nails – Washers – Can and Jar Lids – Steel Boxes – Bottle Caps – Machined Parts – Scrap, etc. For original equipment press manufacturers, small delivery conveyors can be furnished as integral parts to be built into presses for parts delivery.

Models ED and MCS "Space Saver" Conveyors are available in standard lengths and belt widths. Custom series models have length, belt width, magnetic strength, and material flow pattern specially designed to fit specific applications.

Homer's "Job Analysis" service studies your requirements and recommends the proper "Space Saver" Magnetic Conveyors for your needs.

Here's how to obtain complete details Fast! Clip this ad—attach it to your letterhead, include your name, title and department and mail to Homer Manufacturing Division. Bulletins describing Homer Magnetic Conveyors will be sent by return mail.

HOMER MANUFACTURING DIVISION

THE OHIO ELECTRIC MANUFACTURING CO.
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Homer

FIRST IN INDUSTRIAL PERMANENT MAGNETIC CONVEYORS

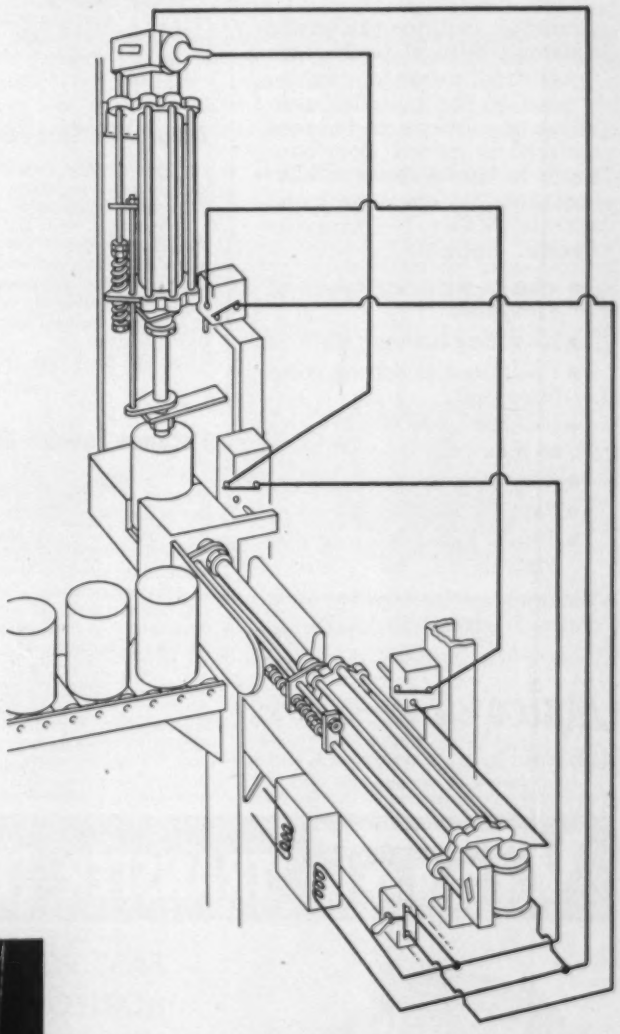
Circle 734 on Page 119

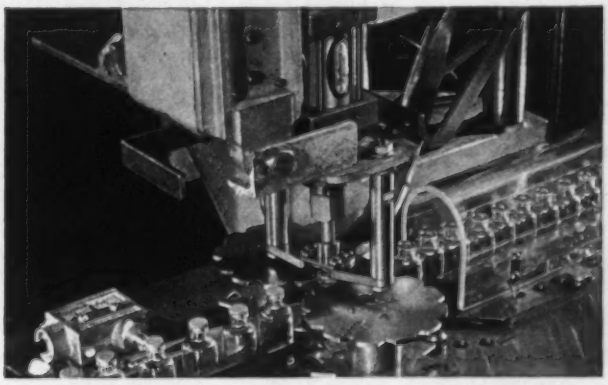
YOU CAN BUILD THIS SIMPLE MACHINE TO LABEL, STAMP, CAP OR SEAL

This SPOT-A-MATION IDEA is another example of how much more simply and economically an operation can be automated using Bellows "Controlled-Air-Power" Devices. The ease of construction and low cost also suggest why these versatile work units have stimulated the imagination and creative ingenuity of cost-conscious men in all types of industries.

Originally designed to punch holes in the bottoms of clay flower pots, this shop-built machine is adaptable to many other operations, such as inserting lids in cans, applying labels, stamping numbers, etc. The two Bellows Air Motors are interlocked to work alternately. A gravity conveyor delivers a clay pot to the first Air Motor, which moves it to a position under the second Air Motor. After the piston rod of the second Air Motor has moved through the work stroke and returned to "up" position, the cycle automatically repeats. This is practical, low-cost automation.

Now, stop a moment and ask yourself a question: "How can I use Bellows "Controlled-Air-Power" to produce more at less cost in *my* plant?"





An adaptation of this SPOT-A-MATION IDEA permitted a drug firm to plug bottles—automatically—four times faster than had been done by two operators. Because sterility was vital, automating the operation with Bellows equipment eliminated the possibility of contamination by human hands.

THIS SPOT-A-MATION IDEA FILE IS YOURS ON REQUEST

Contains installation data, wiring diagrams and equipment lists for scores of Bellows "Controlled-Air-Power" applications, enabling you to automate existing machines or build your own low-cost special-purpose equipment. Write for yours today. No obligation. Address Dept. AU1061, Bellows-Valvair, Akron 9, Ohio.

13438-3

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AKRON 9, OHIO

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

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conveyor systems are easily controlled with Maitrol®. This magnetic memory can be applied to the material, container or conveyor. Addressed material is guided from conveyor to conveyor, vertically, horizontally, over ramps or spirals. Maitrol eliminates transfer problems.

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- Unlimited encoding combinations
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Write today for Maitrol brochure. It gives full details.

Maico electronics inc.
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Circle 736 on Page 119

designed for installation on machine tools and a wide range of other industrial equipment where accurate recording of operating time is desired. Timing motors and time and torque controls are subjects of Form G-1328. Various control models are explained and illustrated.

Circle 503 on Page 119

Shear Pin Sprockets

Browning Mfg. Co., Maysville, Ky.—4 page pamphlet—Catalog CD-104—A illustrates and describes a line of sprockets with shear pin hubs and split taper bushings. The sprockets are designed to prevent damage to expensive machinery due to overloading or jamming. The shear pin hubs are primarily designed for sprockets, but can be used with special sheaves, gears, clutches, etc., to provide protection for almost every type of drive.

Circle 504 on Page 119

Package Labeler-Imprinter

Avery Label Co., 1616 S. California Ave., Monrovia, Calif.—4 page pamphlet—Subject of Brochure AL-1 is a labeler-imprinter, Model 275E, that feeds individual packages onto a conveyor, and prints and affixes labels where desired automatically in a single operation. The unit prints labels and applies them to a variety of flexible envelopes. It can be adapted for rigid containers as well. The imprinter prints descriptive, promotional, or pricing information on blank or preprinted pressure-sensitive labels, which require no moistening, heating, or solvents to make them adhere to a container surface.

Circle 505 on Page 119

Flowsheet Instrument Symbols

Fischer & Porter Co., 946 Jacksonville Rd., Warminster, Pa.—4 page pamphlet—Reference Bulletin 91-53G-02 lists the symbols used by company systems engineers in drawing process flowsheets and schematic control systems. Included are symbols for process piping and lines, solenoids and other valves, measuring elements, and miscellaneous process equipment. In most respects the symbols follow the Recommended Practice outlined by the Instrument Society of America.

Circle 506 on Page 119

Electronic Air Cleaners

Sturtevant Div., Westinghouse Electric Corp., Hyde Park, Boston 36, Mass.—6 page pamphlet—A line of heavy-duty electronic air cleaners with pushbutton automatic control is described in Catalog 1435. Featured are Model PD Precipitron electronic air cleaners suitable for a broad range of industrial and commercial applications including mill motor-room ventilation and make-up air systems. Principles of electronic air cleaning are discussed.

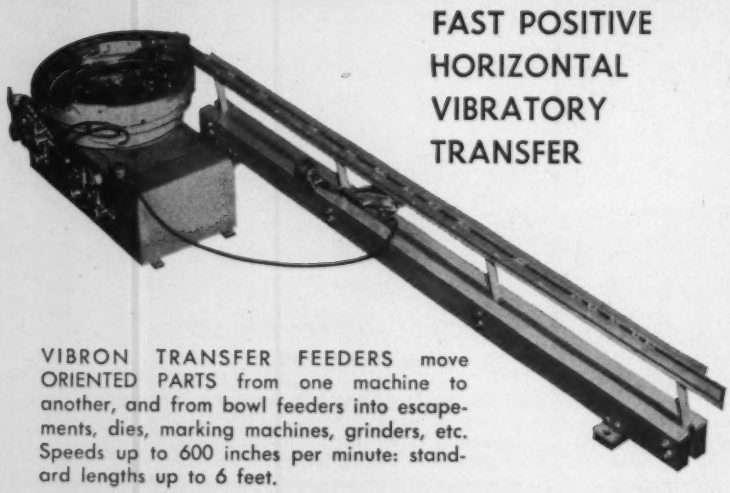
Circle 507 on Page 119

Annunciator Window Bezels

Panellit, Div., ISI Inc., Skokie, Ill.—2 page pamphlet—Bulletin 112 illustrates and describes a line of annunciator snap-on window bezels which permit instant bulb and nameplate changing, without tools. Forward tilt allows easy, nonglare observation of alarm points which are mounted above eye level on a control panel. Directions for replacement of the bezels are given.

Circle 508 on Page 119

VIBRON TRANSFER FEEDER



FAST POSITIVE HORIZONTAL VIBRATORY TRANSFER

VIBRON TRANSFER FEEDERS move ORIENTED PARTS from one machine to another, and from bowl feeders into escapements, dies, marking machines, grinders, etc. Speeds up to 600 inches per minute: standard lengths up to 6 feet.

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Circle 737 on Page 119

Strain Gage Indicators

Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass.—6 page pamphlet—Detailed information on a line of disc indicators used in measuring and control systems employing resistance strain gage transducers is contained in Bulletin 4410. The SR-4 Type 12 disc indicators register load, horsepower, torque, or pressure; require less than a square foot of panel area for mounting, and feature horizontal readout windows. As many as 500 engraved dial graduations can be provided for fast, accurate reading, in pounds, inch-pounds, psi, or other appropriate units. The indicators provide system accuracy to within ±0.25 per cent of full scale.

Circle 509 on Page 119

Heat Exchanger

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—6 page pamphlet—Roto-Fin heat exchanger, designed for high-volume cooling or heating of bulk materials, is subject of Folder 2911. Typical applications outlined or illustrated in the folder cover the processing of flue dust, finished cement, gypsum plaster, foundry sand, copper concentrates, and fluid coke and salt. Illustrated is a laboratory-size heat exchanger available for in-plant testing of various materials.

Circle 510 on Page 119

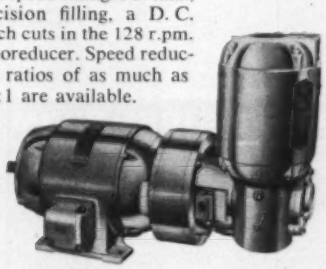
BRING OUT THE FULL MAGIC OF YOUR OWN ENGINEERING KNOW-HOW WITH SPECIAL REULAND MOTORS

Don't ever let a complicated drive requirement stymie your own ingenuity. If you have a design idea, go right ahead with it... leave the motor adaptation to Reuland.

Yes—whatever your needs may be, here is an opportunity to cash in on your own creative designing talents. Typical examples of how others have benefited are shown below. A single experimental motor, or a production run, will receive the same well-known Reuland spirit of cooperation.

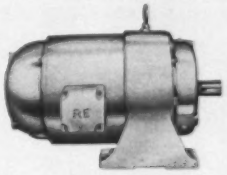
MULTI-DRIVE MOTOREDUCER

Shown here is a typical example of a Reuland multi-drive unit, as adapted for use on a screw conveyor bag filler machine. The primary motor turns the screw for high speed filling. For final, precision filling, a D. C. clutch cuts in the 128 r.pm. Motoreducer. Speed reduction ratios of as much as 100:1 are available.



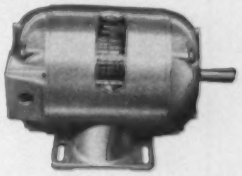
5-STAGE DRIVE CYCLE PACKAGE

A complete, five-stage operating cycle is handled by this one drive package... (1) 100 r.p.m. forward run, (2) immediate stop, (3) fluid-cushioned start again, (4) reverse direction and (5) return at 200 r.p.m. The complete cycle is accomplished by an internal fluid coupling... two-speed, reversing duty motor, gear reducer, and magnetic brake... *within one frame!*



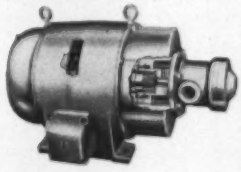
STALL DUTY TORQUE MOTORS

Reuland torque motors can be stalled or "locked" into a load with full current on. The units also automatically adjust their speed to intermittent load changes. Output torques can be changed, as desired, through the use of voltage varying devices. Available in ratings from ½ through 10 foot pounds... for maximum stalls of 5, 10, 20, 60 minute and *continuous.*



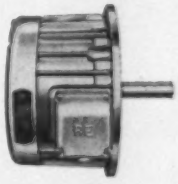
SPLINE COUPLED PUMP MOUNT MOTORS

Reuland spline-coupled hydraulic pump mount motors feature a direct connection between the pump and the motor's shaft... *inside the motor.* The installation is made by simply slipping the spline coupling onto the pump shaft... and attaching the pump to the endbell. The unit eliminates flexible couplings and platform mounts. Reduces mounting space almost 50%. Assures perfect alignment, automatically.



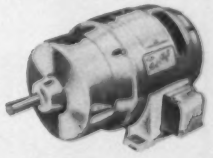
MACHINE TOOL MOTORS

These precision machine tool motors are a completely new type, especially made for the machine tool industry. They are compact in design and built to precise specifications like a fine tool. Their individual dynamic balancing... heavy duty ball bearings... low inertia, lightweight rotor... and even smooth-finished castings, make them a match for the most expensive machine tool.



FLUID-SHAFT BRAKEMOTORS

Reuland Fluid-Shaft motors eliminate shocks and jerks and provide a smooth, gradual, stepless method of load acceleration. Power is transmitted through an internal fluid coupling and all starting inertias are absorbed in a cushion of oil. The Reuland "doughnut" magnetic brake... mounted on the output side of the coupling ...permits extending the motor shaft right through for load hook-up.

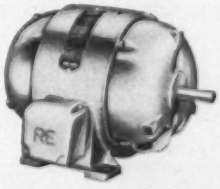


HOLLOWSHAFT WORM MOTOREDUCERS

This unique, right-angle Motoreducer features a *hollow shaft* that permits direct-coupling to equipment by merely inserting the drive shaft of the machine. No other mounting arrangement is required, except the torque arm which serves as an "anchor" for the Motoreducer. Eliminates the need for couplings, brackets, or belt and chain drives. Mounts in very tight areas.

MULTI-SPEED MOTORS

Basic designs consist of three predetermined speed rating selections; 2-speeds, 3-speeds and 4-speeds. The motors are also available with three torque-horsepower-speed combinations. (1) Constant torque ...h.p. varies directly with r.p.m. (2) Variable Torque... h.p. variation is proportionate to the square of the speed, and (3) Constant horsepower... wherever h.p. need is constant regardless of operating speed.



DISC-TYPE MAGNETIC BRAKES

Reuland "through-shaft" magnetic brakes feature a fast and sure direct action principle. Levers and linkage are eliminated by a simple attraction and release action between the armature and "doughnut" type magnet. Available for use with all makes of motors in (1) *endbell* type, (2) *foot mounted* and (3) *foot mounted—complete with own bearings and shaft.*

MODERN POWER FOR MODERN-DAY PRODUCTS...*all in lightweight aluminum frames*

Our new 8-page catalog No. GS-8-30-0, will come in handy. Sent complete with prices and engineering drawings on request.

REULAND MOTORS

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Circle 738 on Page 119

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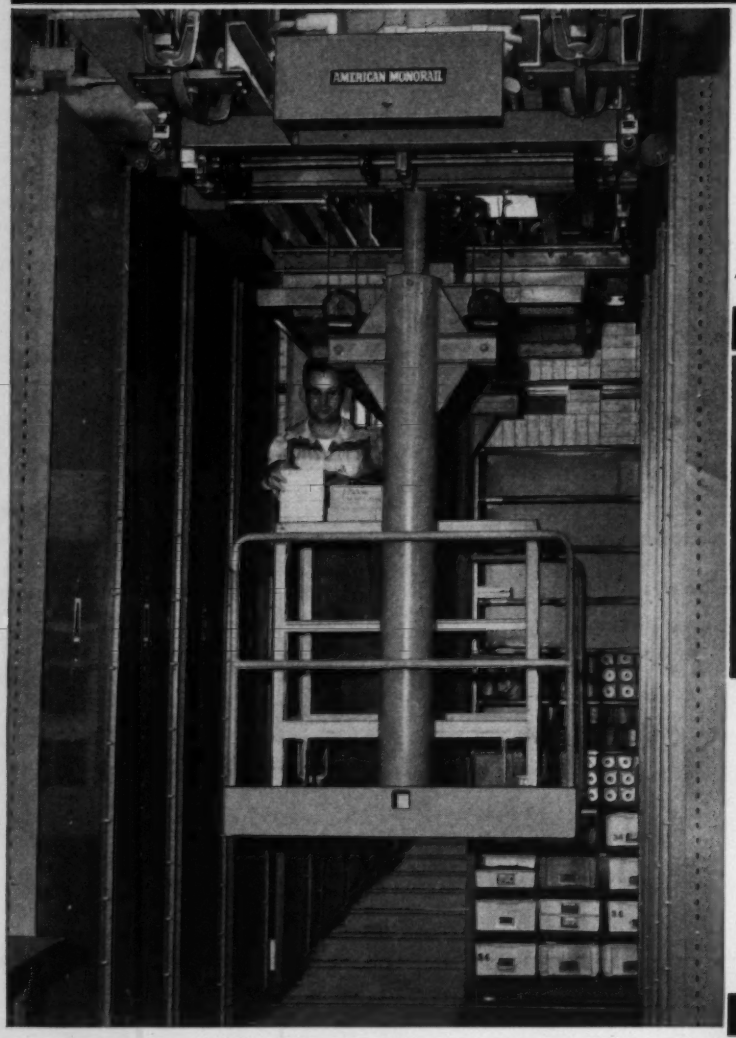
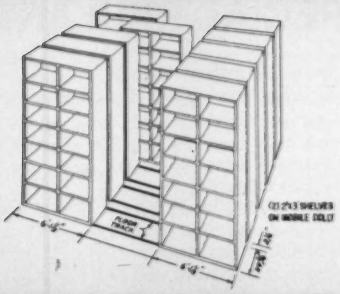
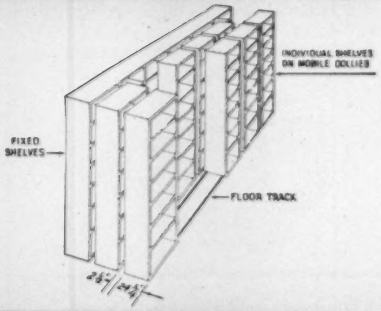




ACTIVE STORE ROOM



INACTIVE STORE ROOM

An American Monorail carrier plus mobile shelves added 7,500 sq. ft. of usable storage space to a Pennsylvania plant.

Ten foot high shelving units equipped with grooved wheel dollies ride on double rails mounted flush to the floor. Shelf units roll out into the aisle smoothly with a pull equal to 1% of their total weight. The Monorail carrier, used for loading and unloading shelves, has a photo cell safety device that prevents running into a shelf unit.

Major Benefits: Stock stays cleaner and the amount of space required for aisles is cut in half.

Free Folder — pictures and describes stacking by specialized American Monorail Stackers in many types of warehouses. Write for Bulletin SB-1.

ENGINEERED MATERIALS HANDLING

AMERICAN MONORAIL

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DIVISIONS: Conveyor Division, Tipp City, Ohio — Canadian Monorail Co., Ltd., Brampton, Ont.

AUTOMATION abstracts

THE CHALLENGE IN CONTROL

By C. C. LASHER
Gen. Mgr., Computer Dept.
General Electric Co.
Phoenix, Ariz.

SUCCESSFUL establishment of process control by computers is one of the greatest challenges of today. It holds the key to many of the fundamental problems facing the free world: Rising labor costs, increased labor dominance, foreign competition from nations with low labor costs, and the intense competition for national productivity with the eastern bloc nations. Just as proper adaptation of mechanization brought this country to where it is today, so will the successful utilization of industrial automation bring about continued rising standards of living, productivity and stability. In spite of a short history, the extent to which process computers have been put to use is remarkable. It is sufficient to just mention that there are at least 50 installations and 120 orders of process computers placed in the industry to date. Many installations have demonstrated better than 99 per cent availability over an extended period of time. There is a significant number of users that have derived proven tangible and intangible benefits and are ordering their second and third round of process computers. The scope of process computer application is also extending horizontally as well as vertically; horizontally to include multiple processes, vertically to include integration with the instrument-controllers, production scheduling and accounting procedures. Electronic instrumentation, once virtually unknown in many industrial applications, is becoming the pride and joy of plant designers for power plants and chemical plants. It is encouraging that many new power plants, steel mills, and chemical plants are including process computers in their planning. In short, process computers have made a fine beginning and are here to stay.

Reliability

Reliability in the broad sense implies the providing of maximum useful service with a minimum of care over an extended period of time. Thus, it is not enough to design inherently reliable equipment. A long mean error-free operating time for the system is a good beginning, but we must go on to consider such things as: Fail safe design, ease of diagnosis, ease of repair, and partial system operation.

Fail safe system design recognizes that any equipment is bound to have failure some time in the future, but should it fail it should fail in a manner so as not to endanger equipment or personnel. For example, it is common practice to have process computers direct the set points of instrument controllers in a chemical plant. Let's say it is desirable to have the process continue in the event of computer outage, but without the optimization calculations for set point adjustments. A way to provide this fail safe operation is to provide whole number analog outputs from the process computer to instrument-controllers with individual digital to analog channels, magnetically latching relays as memory for each digital to analog channel, and separate power supply for the digital to analog section.

Ease of diagnosis and ease of repair go hand in hand together. Automatic built-in or programmed diagnosis of malfunction would go a long way towards reducing down time duration and achieving a higher uptime for the system.

Partial system operation is a state of bliss which is enjoyed by analog techniques but a "gleam in the eye" for process computers at the present state of the art. The entire digital computer system may fail due to one component, where an equivalent analog system may still continue to perform many useful functions correctly should one or more components malfunction. The ideal is to achieve a partial or reduced (but correct) process computer operation on a planned basis when one or more of the key components should fail.

Simplicity

Simplicity is a requirement of industrial automation. It may be a unique and unfamiliar restraint to many electronic engineers. Not only should the equipment be simple and relatively easy to apply, but it should require a minimum of effort, delays and process outage during the installation and check-out phase. After that, the maintenance procedure should be mere "replace and repair the component later."

Extreme flexibility of the equipment does not necessarily lead to simplicity of application of process computers. In fact, extremely flexible digital systems can lead to many problems. In the analog computing technology, extreme flexibility is taken for granted. The application engineer is frequently the same person as the design engineer. He works from standardized modules or components; every few pages (or volumes) of functional specifications become ultimately so many racks of hardware. As long as he properly applies these modules or components, he is assured of coming up with a good system. This relatively simple approach is no longer desirable and may not be even feasible with process computers for the following reasons: 1. The digital computer capabilities (speed, memory, input-output) come in fixed steps with large increments between steps. 2. If we make every digital computer different, the automatic programming techniques which are potentially capable of reducing programming costs by orders of magnitude would be virtually inapplicable. 3. If we only standardize on the module or

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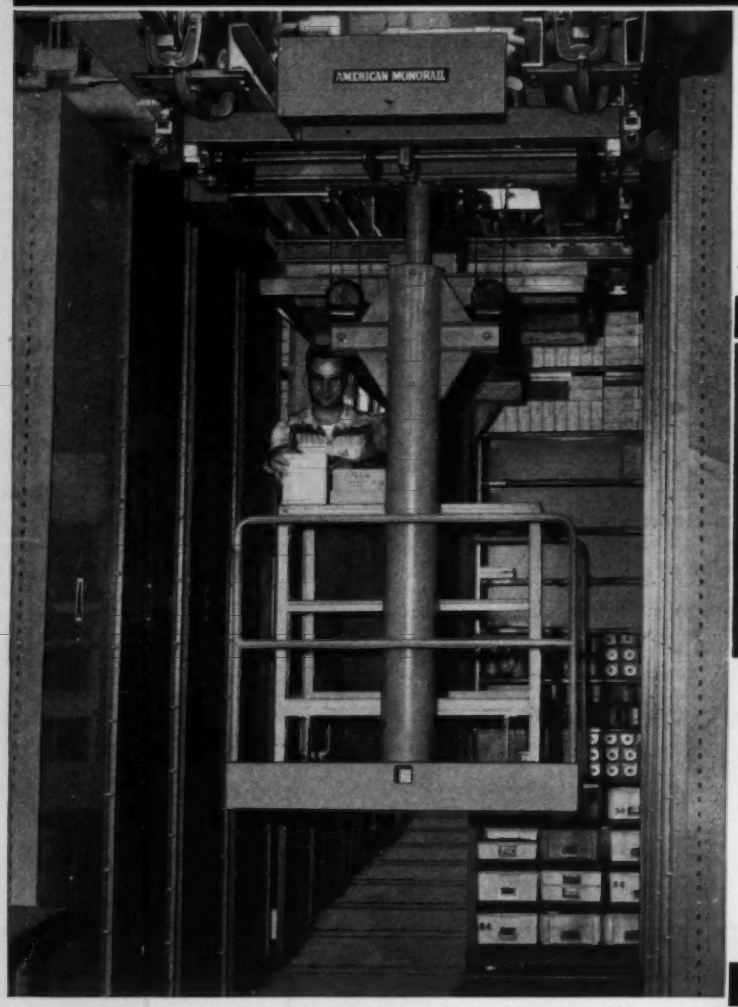
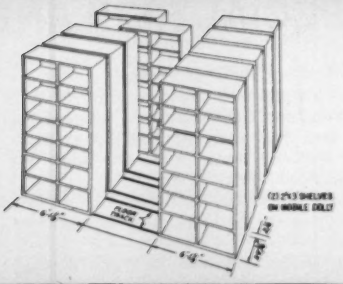
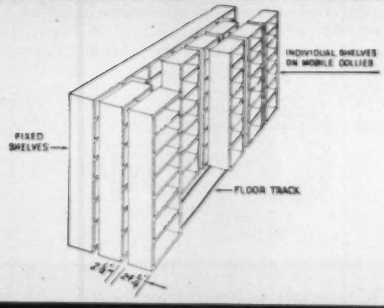




ACTIVE STORE ROOM



INACTIVE STORE ROOM

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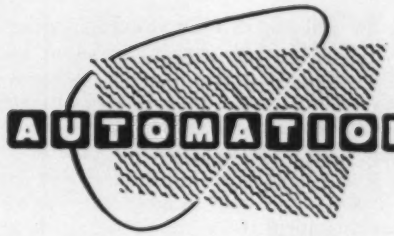

abstracts

THE CHALLENGE IN CONTROL

By C. C. LASHER
Gen. Mgr., Computer Dept.
General Electric Co.
Phoenix, Ariz.

SUCCESSFUL establishment of process control by computers is one of the greatest challenges of today. It holds the key to many of the fundamental problems facing the free world: Rising labor costs, increased labor dominance, foreign competition from nations with low labor costs, and the intense competition for national productivity with the eastern bloc nations. Just as proper adaptation of mechanization brought this country to where it is today, so will the successful utilization of industrial automation bring about continued rising standards of living, productivity and stability. In spite of a short history, the extent to which process computers have been put to use is remarkable. It is sufficient to just mention that there are at least 50 installations and 120 orders of process computers placed in the industry to date. Many installations have demonstrated better than 99 per cent availability over an extended period of time. There is a significant number of users that have derived proven tangible and intangible benefits and are ordering their second and third round of process computers. The scope of process computer application is also extending horizontally as well as vertically; horizontally to include multiple processes, vertically to include integration with the instrument-controllers, production scheduling and accounting procedures. Electronic instrumentation, once virtually unknown in many industrial applications, is becoming the pride and joy of plant designers for power plants and chemical plants. It is encouraging that many new power plants, steel mills, and chemical plants are including process computers in their planning. In short, process computers have made a fine beginning and are here to stay.

Reliability

Reliability in the broad sense implies the providing of maximum useful service with a minimum of care over an extended period of time. Thus, it is not enough to design inherently reliable equipment. A long mean error-free operating time for the system is a good beginning, but we must go on to consider such things as: Fail safe design, ease of diagnosis, ease of repair, and partial system operation.

Fail safe system design recognizes that any equipment is bound to have failure some time in the future, but should it fail it should fail in a manner so as not to endanger equipment or personnel. For example, it is common practice to have process computers direct the set points of instrument controllers in a chemical plant. Let's say it is desirable to have the process continue in the event of computer outage, but without the optimization calculations for set point adjustments. A way to provide this fail safe operation is to provide whole number analog outputs from the process computer to instrument-controllers with individual digital to analog channels, magnetically latching relays as memory for each digital to analog channel, and separate power supply for the digital to analog section.

Ease of diagnosis and ease of repair go hand in hand together. Automatic built-in or programmed diagnosis of malfunction would go a long way towards reducing down time duration and achieving a higher uptime for the system.

Partial system operation is a state of bliss which is enjoyed by analog techniques but a "gleam in the eye" for process computers at the present state of the art. The entire digital computer system may fail due to one component, where an equivalent analog system may still continue to perform many useful functions correctly should one or more components malfunction. The ideal is to achieve a partial or reduced (but correct) process computer operation on a planned basis when one or more of the key components should fail.

Simplicity

Simplicity is a requirement of industrial automation. It may be a unique and unfamiliar restraint to many electronic engineers. Not only should the equipment be simple and relatively easy to apply, but it should require a minimum of effort, delays and process outage during the installation and check-out phase. After that, the maintenance procedure should be mere "replace and repair the component later."

Extreme flexibility of the equipment does not necessarily lead to simplicity of application of process computers. In fact, extremely flexible digital systems can lead to many problems. In the analog computing technology, extreme flexibility is taken for granted. The application engineer is frequently the same person as the design engineer. He works from standardized modules or components; every few pages (or volumes) of functional specifications become ultimately so many racks of hardware. As long as he properly applies these modules or components, he is assured of coming up with a good system. This relatively simple approach is no longer desirable and may not be even feasible with process computers for the following reasons: 1. The digital computer capabilities (speed, memory, input-output) come in fixed steps with large increments between steps. 2. If we make every digital computer different, the automatic programming techniques which are potentially capable of reducing programming costs by orders of magnitude would be virtually inapplicable. 3. If we only standardize on the module or

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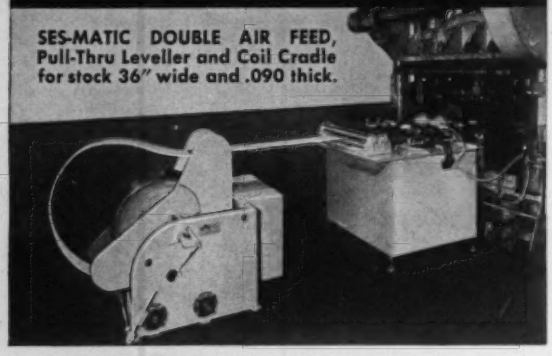

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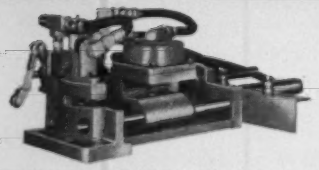

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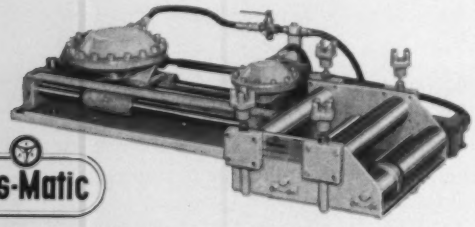

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component level, we will not be able to devote the required prototype and production engineering effort for each system because every system will be different. 4. With the stored program technology, fortunately, we are not faced with the choice of either designing the hardware to fit the process or designing the process to fit the hardware. The hardware can and should be standardized on a fairly high level to meet the requirements and cost constraints of the supplier, and made to fit the needs of the process by programming.

To summarize, extreme flexibility is not necessarily required or desirable for process computers. A higher degree of step-wise standardization on the functional or systems level will go far towards making process computers easy and simple to understand, apply and implement.

Since the unique features of process computers, in contrast with business or scientific computers, is on-line, real-time operation, the acceptance of process computers once again points out the need for on-stream sensors and analytical instruments. Devices such as X-ray gauges, chromatographs are good beginnings, but many more such devices are needed. For example, on-stream flue gas analysis of the boiler, continuous BTU analysis of coal are some of the devices urgently needed.

Needless to say, since process computers can readily accept d-c analog signals and contact closures as inputs, and can provide contact closures, whole number analog voltage or pulse voltage as output, there is a great deal of work to be done to make the sensors, transducers, analytic instruments and controllers compatible with process computers.

Operational Problems

The major restraints affecting the application of process computers to industrial operation are costs and the level of competence among the operating and maintenance personnel of the user.

Unlike military applications, process computers for industrial operation must pay for themselves by one or more of the following justifications: Increased efficiency, increased safety, increased yield or throughput, improved quality and/or consistency of product, decreased manpower, decreased instrumentation, and/or research tool.

Some of these justifications are difficult to evaluate in a quantitative manner. Yet the constraints for a 3 year pay-out for the chemical industry, 4-5 year pay-out for the steel industry are realities which we must face.

The level of competence among the operating and maintenance personnel is another constraint which the engineers designing these systems should take into consideration. In many cases, the same operator who is responsible for the maintenance of the instrumentation is also responsible for the maintenance and operation of the computer hardware and program. Thus, the equipment and program should be well documented, easy to maintain, and changes should be easy to make.

The industrial environment of dust, vibration, ambient temperature, signal noise, and power transients are only some of the factors which the equipment should be designed to meet; otherwise, means should be found to circumvent degradation of computer operation due

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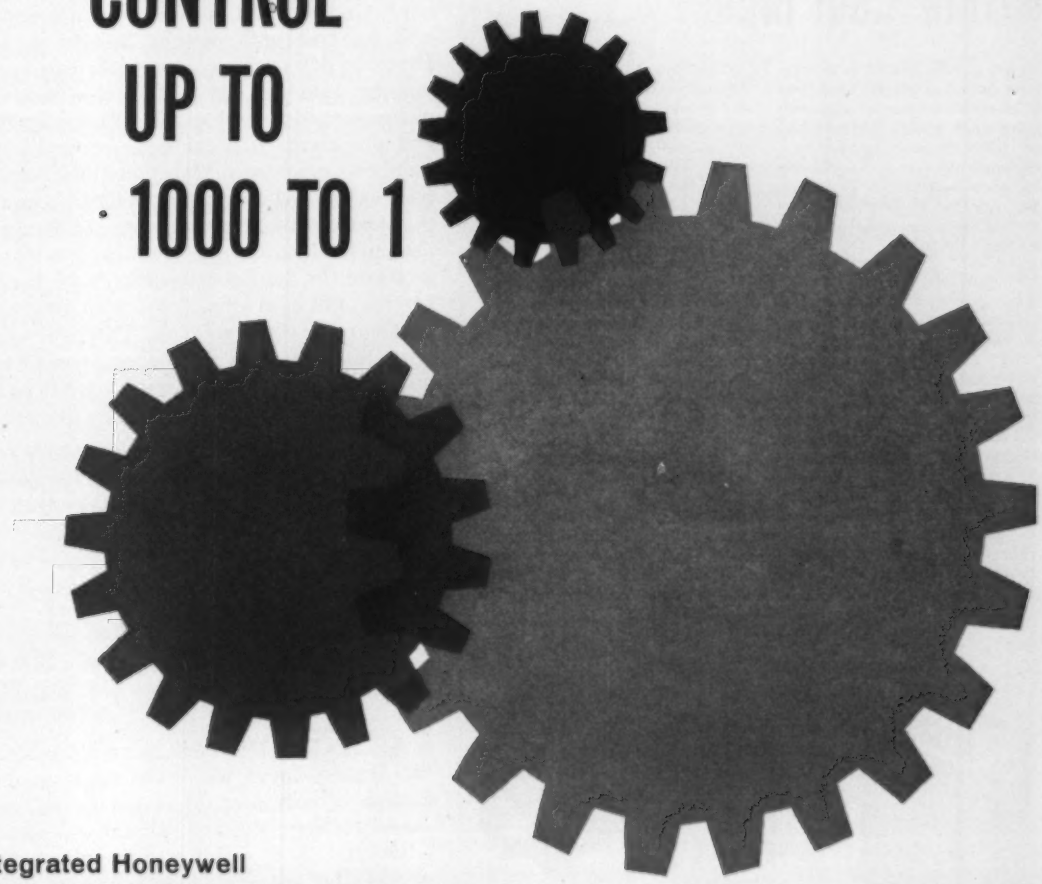
SPEED CONTROL UP TO 1000 TO 1



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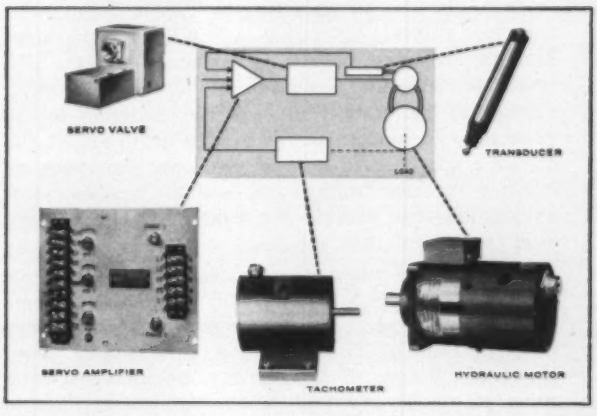

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Circle 741 on Page 119

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to industrial environment.

In the past, certain segments of the industry have traditionally looked to the equipment suppliers for a close technological partnership. In many cases, the entire burden of "systems engineering" is placed on the supplier. The user only purchases a "functional black-box." Undoubtedly, this close technological partnership will continue with obvious benefits to both parties. However, due to the secrecy regulations in the chemical industry, and the fact that process computers are implementing to a large extent, plant operating practices and procedures, it is no longer desirable for the user simply to purchase a "functional black-box." The user must be trained in systems analysis, computer application and programming so he can at least participate in the implementation. In fact, the user will not be able to derive the maximum benefits from process computer control until he is intimately familiar with computer application and programming. This will enable him to select functions with the highest "benefit to cost ratio" and enable him to implement his entire plans including operating practices and procedures in spirit and intent.

From a paper entitled "New Problems For Electronic Engineers," presented at 1961 *7th Regional IRE Technical Conference, Phoenix, Arizona, April* 1961.

MINERAL PROCESSING

By ROBERT J. BRISON
Mineral Processing Specialist
Battelle Memorial Institute
Columbus, Ohio

A RECENT STUDY led to predictions that by 1980 the United States will have adequate domestic production of only 6 of 23 major mineral raw materials —coal, cement, gypsum, phosphate, potash, and molybdenum. It was also predicted that imports of most of the other materials would have to be substantially increased if the nation is to maintain adequate supplies of all minerals.

Obviously, the advancement of United States technology in mineral processing is of critical importance. The improvements of existing processes and the discovery of new ones can mean the difference between abundance and scarcity of basic raw materials in the years ahead. Modern trends in mineral research—the scientific approach to mineral problems, the closer relation with other technologies, and the application of automation—can provide the means for achieving the kind of progress that is needed.

In this age of automation, mineral processing plants will be no exception to the trend toward the ultimate goal of completely automatic control. This industry has long been highly mechanized; in a modern plant, thousands of tons of ore per day are processed from mine to smelter without being handled by human hands, and with only a few operators in attendance.

But automatic control in the industry is in its infancy. The problems involved have been formidable—such as automatically analyzing for several elements a slurry of solids suspended in water or delivering a suitable sample to the analyzer. The large number of production units requiring individual control also adds

to the complexity. Major advances are being made toward solving these problems. In this area, too, much of the needed know-how is becoming available from other fields.

Particularly significant is the rapid progress in development of automatic equipment for on-line analysis of slurries and solids by the x-ray fluorescence spectroscopy method. Such a unit has been installed at the Anaconda copper concentrator in Montana. As a step toward the rapid analyses required for the constant control of automatic processes, equipment that will analyze samples for six elements and record the results within 2 minutes is now available. Conventional methods, on the other hand, could provide the same data only after an extended period (often 8 hours or more); and meanwhile a considerable tonnage of ore would have passed through the process.

Analysis of products is, of course, only one of many essential control factors in a mineral processing operation, and many kinds of measurement and control equipment will be needed. Already, devices such as gamma-ray absorption meters for level and density control and electromagnetic flowmeters appear destined to become commonplace in the mineral processing plants of tomorrow along with the already well-established control devices.

Much of the instrumentation for automation of mineral processing will be "imported" from other fields of technology. But a large part of the new knowledge will have to come from research in the mineral industry itself. This research will include:

1. Application and adaptation of available control equipment to mineral processing
2. Development of special equipment and techniques as needed, for example, development of means to deliver samples to automatic analyzers
3. Basic research to improve understanding of mineral-processing operations and thereby lay a firm basis for establishing the principles of control
4. Modification of existing processes to make them more amenable to automation
5. Development of new processes better suited to automation than existing processes
6. Study and design of the over-all operation and control of the mineral processing plant as a unified system.

From an article entitled "Trends In Mineral Research," appearing in the "Battelle Technical Review," July 1961.

EXPLOSIVE FORMING

By JAMES P. ORR
Ryan Aeronautical Co.
San Diego, Calif.

EXPLOSIVE FORMING, a new manufacturing technique, is taking its place in modern aircraft and missile fabrication. Many development programs have been conducted to evaluate high energy forming. The results of these programs have provided sufficient data from which to draw some worthwhile conclusions. Principal explosive forming advantages are:

Size. Parts to be explosively formed are not restricted in size to present equipment capacity, but by other restricting factors—sheet size, die size, or the ability to handle either the die or the material. In this regard,

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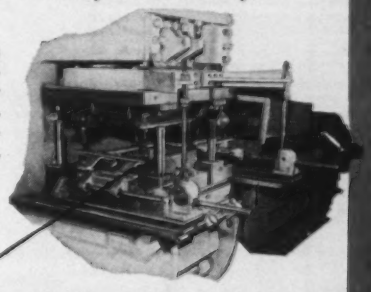
Press application of small 3-station line transfer unit shown.
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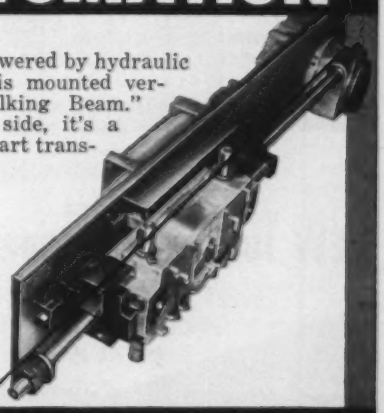
Standard unit powered by hydraulic or air cylinder is mounted vertically for "Walking Beam." Mounted on its side, it's a "Shuttle Type" part transfer unit.

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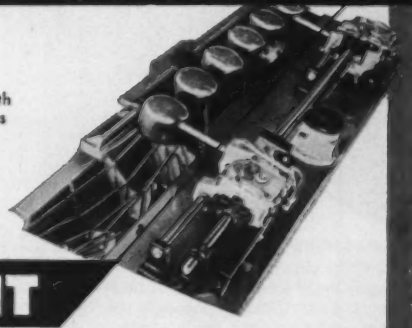
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Circle 743 on Page 119

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2. Exclusive built-in sensing, assures that screw is driven. Automatically retracts driver only after attaining proper torque.
3. Complete automatic cycle, requires only a touch of the pedal.
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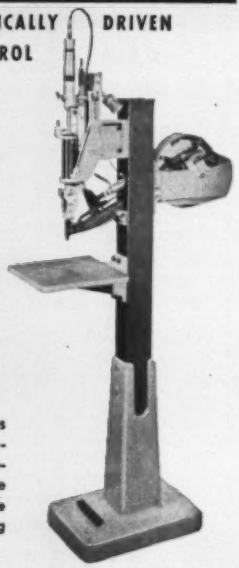
6. Two ranges of torque available 0 to 84 inch-pounds and 48 to 120.
7. Work height adjustment with 14" range, can be made without in any way disturbing the machine adjustments.

The new DIXON *Auto-Torque Driver* includes all the features of the DIXON Auto-Positioner, and has an efficient space-saving air motor with an adjustable-torque clutch. These features provide for *positive* handling, giving new efficiency in driving screws and nuts.



Full information available in bulletin No. SD-81.

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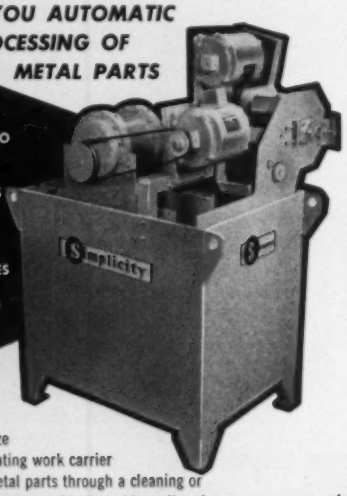

The new Simplicity Junior Size Vibra-Washer employs a vibrating work carrier that automatically conveys metal parts through a cleaning or conditioning bath. It cleans so thoroughly that chips, oil and grease are removed from even blind or slotted openings; cleans so gently even the most delicate threads or flanges are not harmed.

If you have a tough cleaning or conditioning job, Simplicity Engineering Company can help. For information, write or call the Industrial Washer Division.

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a technique has been developed to construct the die right in the ground, either of concrete with an epoxy face or concrete with a steel face. In this manner, dies of 50 or 60 feet in diameter may be constructed.

Pressure of Forming Force. Sufficient pressure and capacity for forming the strongest new superalloys is available through the medium of explosive forming. Pressures in excess of those obtainable by the largest, most modern conventional machines are readily generated by explosives.

Forming Speed. Conventional machines form metals at speeds up to 5 fps; explosive forming utilizes speeds up to hundreds of feet per second. Although still in the research stage, some tests have indicated that high rates of forming speed show advantages over slower forming speeds in increased elongation.

Cost Reduction. Explosive forming, as a manufacturing technique, will not replace conventional equipment. As a general rule, if the part can be formed satisfactorily, conventionally, it is more economical to do so. Of course, there are exceptions to this: Extremely large parts, parts with unusual contours, close tolerance parts, and parts requiring heavy pressures generally lend themselves to explosive forming.

Reduced Spring-Back. Parts have been consistently produced to within 0.001 or 0.002 inch of the die. This is possible because of the lack of spring-back encountered in explosive forming.

Work Hardening. Material formed by explosive means may be work hardened, and this is proportional to the severity of the form. Normal annealing methods may be employed, as with conventional forming. This may be carried on between explosive forming shots. It is generally not necessary to build stage dies in explosive forming work since the material may be moved by small explosive charges a portion of the way to the die, annealed, re-installed in the die, and finish formed. Work hardening has been used to advantage in obtaining high tensile strength in certain alloys which are not heat treatable.

Disadvantages.

The great disadvantage to explosive forming, at present, is the amount of time consumed in loading and unloading the part from the die. The difficulty here is that a vacuum must be secured between the part and the die so as not to allow air compression in the die cavity. The necessity of drawing this vacuum has resulted in complicated die designs in which sealing problems slow down the handling procedure. Perhaps as new tooling techniques are established, this delay may be minimized.

Another disadvantage is the complex problem of explosively forming materials at elevated temperatures. This has been partly overcome through the use of alluvial sand as a shock transmitting medium instead of water. In this manner, electrically heated dies have been used to 1000F temperatures. Titanium metals have been successfully formed with a minimum of spring-back and metal thinning by the use of this technique.

From a paper entitled "High Energy Forming New Manufacturing Techniques," presented at the 1961 Society of Automotive Engineers National Aeronautic Meeting, New York, April 1961.

confidential file

Problems concerning systems, equipment, or components for automated operations are invited. Submit to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solutions to problems are invited to submit them and should refer to problem title and case number.

FINISHING PLASTIC CONTACT LENSES **Case 2500-P**

. . . We have heard of a method of vibration-finishing parts in which the parts are mixed with abrasive grains in a container which is then vibrated rapidly, causing the grains to deburr and polish rough edges, protrusions, and internal corners. We are interested in using such a process for rounding, smoothing, and polishing plastic contact lenses at various stages of manufacture. What companies make such vibration-finishing equipment and what kind and size of abrasive grains would be recommended for use with our product? . . . Engineer

DETECTING BREAKS **Case 2503-P**

. . . One of our automatic machines uses both thread and 1/64-inch diameter staple wire, each supplied from reels. Our problem is to find some means of shutting down the machine if either the thread or wire breaks between the reels and the machine. Speed of the thread is 100 feet per minute, and speed of the wire is 8 feet per minute. . . Packaging Engineer

NUMERICAL CONTROL SYSTEM **Case 2504-P**

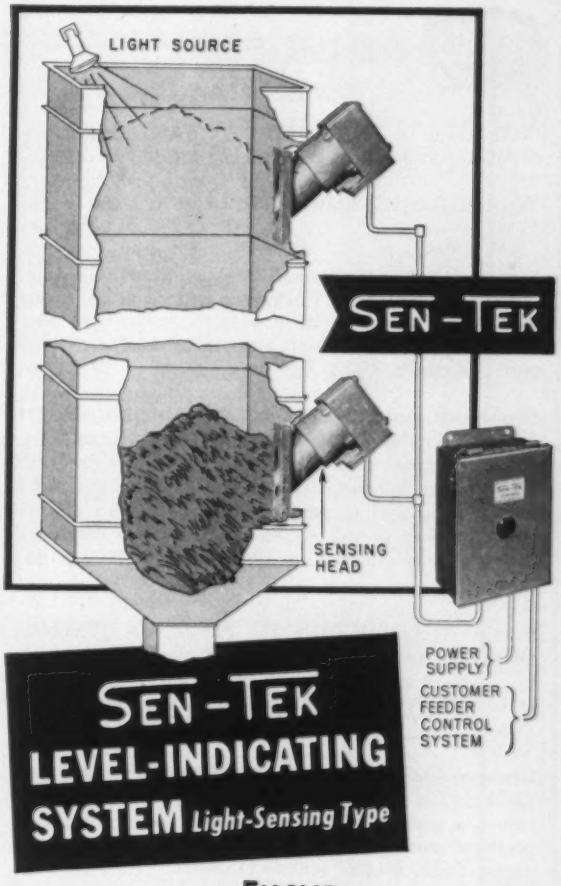
. . . We are in need of an inexpensive, slow speed, low accuracy, punched paper tape preparation and numerical control system for *X-Y* co-ordinates plus additional commands, with provisions for visual display, parallel entry, and manual inputs. . . Engineer

SEPARATING CHIPS FROM PARTS **Case 2505-P**

. . . We are a manufacturer of ball bearings. The outer and inner races are turned on automatic machines and dropped into tote pans. Unfortunately, long spiral chips also find their way into the tote pans. The parts are then dumped into a hopper where they are picked up by a conveyor and brought into a chute attached to a grinding machine. The spiral chips jam the chute, and the operator has to manually remove them. We need sorting equipment that would separate the chips from the parts before they enter the chute. . . Tool Designer

REMOVING BOW FROM STRIP **Case 2506-P**

. . . We are looking for a method or machine which will remove the crosswise bow or crown from coiled stock, 8 to 13 inches wide, before or after it passes through a straightening and feeding machine. This crown is due to the stock being formed and is not due to a greater thickness at the center. The crown causes the straightener rolls to leave creases across the stock each time the straightener and feed stops for a punch press cutoff operation which means that the creases appear in each piece. This condition does not exist in coils that are flat across the width of the stock. . . Manager Plant Engineering



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The author has compiled and arranged this dictionary on an English alphabetical base. Corresponding words in French, Spanish, Italian, Dutch, and German are arranged horizontally alongside of English equivalents. In addition, for each language, an alphabetical list of words contains a code number reference to the basic English list.

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By E. D. Chapple, president of E. D. Chapple Co. Inc. and L. R. Sayles, professor of management, Graduate School of Business, Columbia University; 218 pages, 6 by 9 inches, published by Macmillan Co., New York; available from AUTOMATION; $6.50 *postpaid.*

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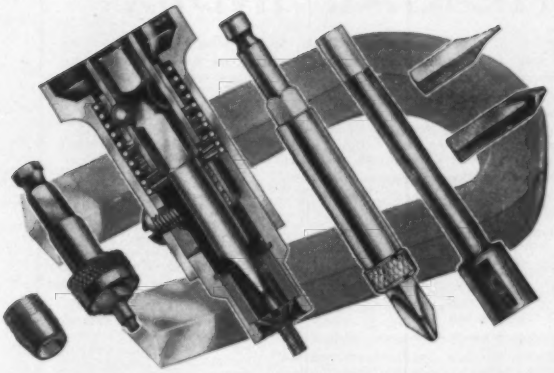

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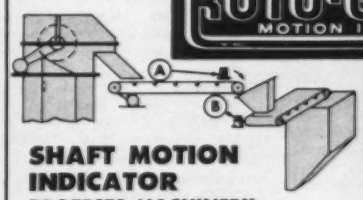

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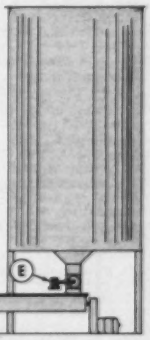

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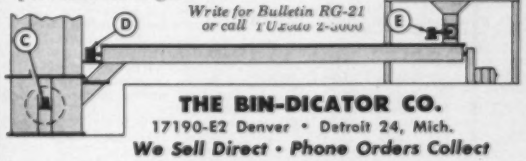

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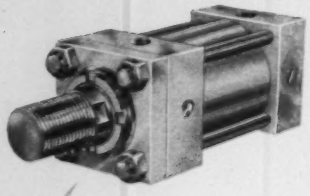

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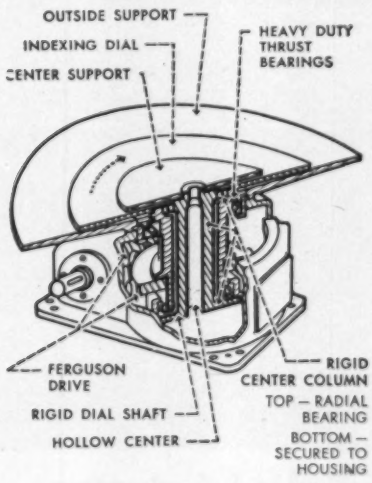
How INDEX TABLE *DESIGN* affects INITIAL PRICE and TOTAL COST

Study these drawings to see how the design of an index table affects total costs of an installation. Some tables may be priced lower than others initially, but the additional charges for auxiliary items to adapt them to production requirements, added to maintenance and downtime costs, can make a drastic difference in the total price.

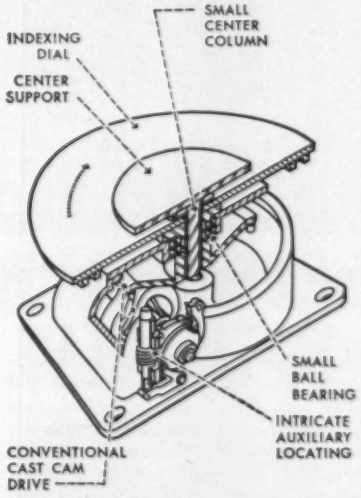
FIG. 1—FERGUSON INTERMITTOR



The Ferguson Intermittor, indexed by a roller gear drive which operates a minimum of 8,000 hours at speeds up to 2,000 indexes a minute without maintenance, needs no auxiliary locking. It is designed for high speed operation and incorporates rigid integral supports for tooling to eliminate expensive segmental components. The Intermittor dial is supported by tapered roller thrust bearings to withstand heavy loads with little friction. A stationary center tooling support is held rigidly at its top by anti-friction radial bearings and at the bottom by a flanged base bolted to the housing. Hollow center of the support may be used for passage of coolants, fluids, air or vertical shafts to transmit motion to the work surface.

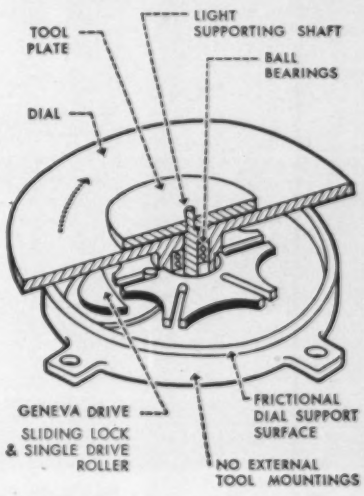
Figures 2 and 3 show typical barrel cam and geneva drive index tables. Their indexing mechanisms limit operating speeds, therefore other components may be "designed down." Shafts and bearings are lighter; frictional support surfaces might be employed instead of thrust

FIG. 2—BARREL CAM TYPE



bearings and an auxiliary locking or locating device is a costly necessity for even modest accuracy requirements. Tool mounting methods are often provided at additional expense and sometimes even ignored. Difficulties of installation and frequent maintenance downtime can increase total cost drastically.

FIG. 3—GENEVA DRIVE TYPE



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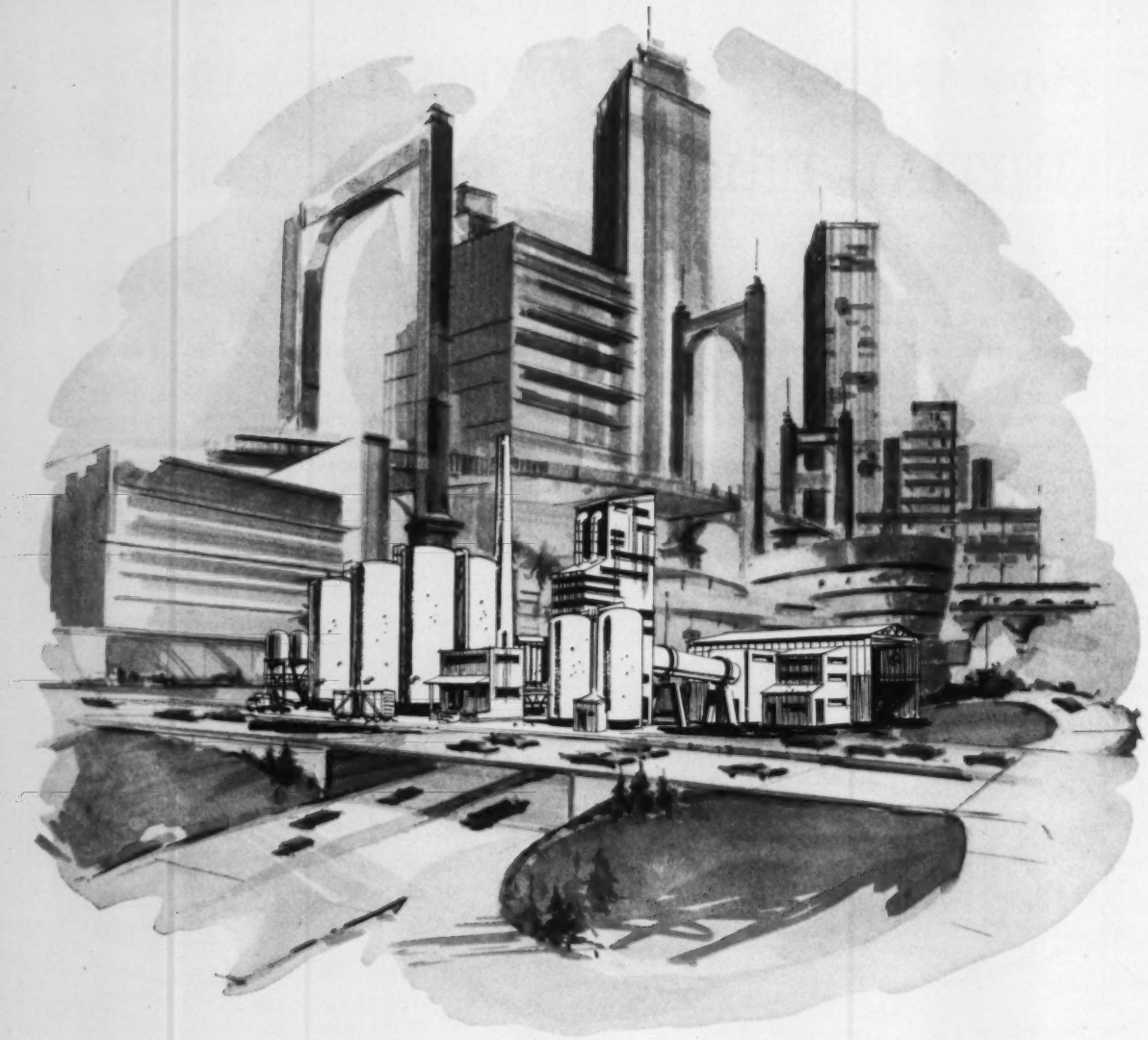

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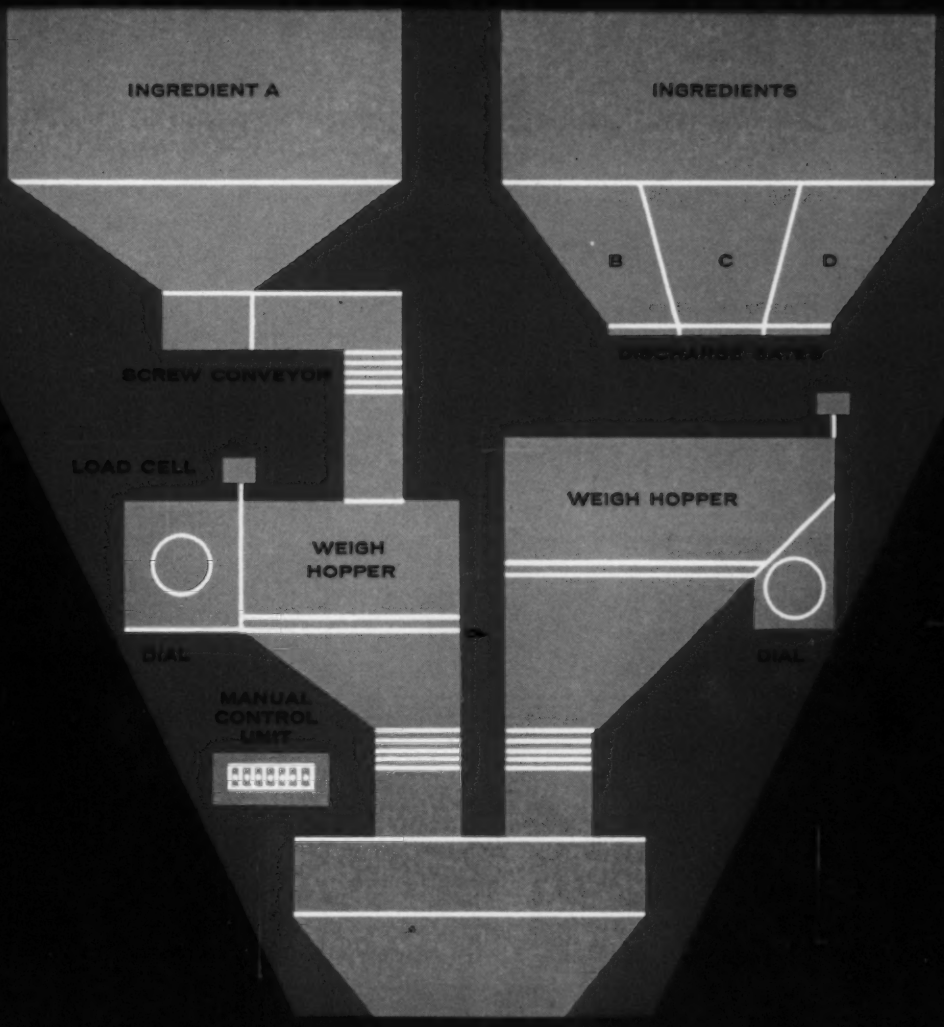

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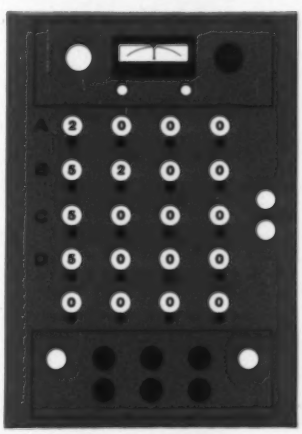

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